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U. S. Hopper Dredge "W. L. Marshall"

ONE of the four largest and most important sea-going dredges in government service. Electrically equipped throughout, even to the use of current for heating and cooking.

The three 700-kw. main generators and two 150-kw. auxiliary generators in each of these vessels are driven respectively by three 1000-b.hp. and two 225-b.hp.

**McINTOSH & SEYMOUR
DIESEL ENGINES**



Volume XI No. 9

SEPTEMBER 1926

Price 35 Cents

ARTICLES on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

ILLUSTRATIONS of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

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Vol. XI

September, 1926

No. 9

Great Lakes Dredge is Diesel-Electric

Ms. Sandmaster, Owned by Construction Materials Co., Chicago,
Shows a Saving of Nearly \$2,000 Per Month Over Steamers,
and Has Greater Flexibility of Operation

SAVING of \$500 to \$1,000 per month in fuel cost alone, with Diesel oil at 5c per gal. and coal at \$5.00 a ton, to which must be added the saving, including insurance and subsistence, of approximately \$1,100 per month in crews' wages and keep is to be realized with SANDMASTER, a converted "Lake" type Shipping Board cargo vessel, first and only Diesel-electric pipeline hopper dredge on the Great Lakes, owned and worked by Construction Materials Co., Chicago. Fourth unit of this company's fleet, she operates out of Chicago, proceeding light to a region of Lake Michigan about 40 miles out, where she loads sand through her suction pipes, transporting it to the Construction Material Co.'s wharves at Chicago and South Chicago, for use in various constructional works. Two Diesel engines of 600 hp. each drive 410 kw. generators and 50 kw. exciters and the current so generated supplies power for two 500 hp. propelling motors, two 400 hp. 18 in. centrifugal sand pumps, and the whole of the auxiliary machinery of the ship.

Dredge SANDMASTER was until the fall of 1924 the "Lake" type Shipping Board vessel LAKE WEIR, an ocean freighter built at Lorain in 1918. At the time of purchase by J. R. Sensibar, president, Con-

struction Materials Co., LAKE WEIR was in dock at Newport News, Va. Sailing from this port under her own power, she arrived in Cleveland late in 1924, stopping at New York and Buffalo en route, where she took on board the Diesel engines that were to drive her generators. Rebuilding and conversion was done by the Interlake Engineering Company, Cleveland, Ohio. In December, 1925, after the hull alterations were completed and the main engines and auxiliaries installed, SANDMASTER was towed to the Cleveland plant of the American Shipbuilding Company. Here she was placed in dry dock, fitted with "A" frames and twin propellers and her propelling machinery lined up.

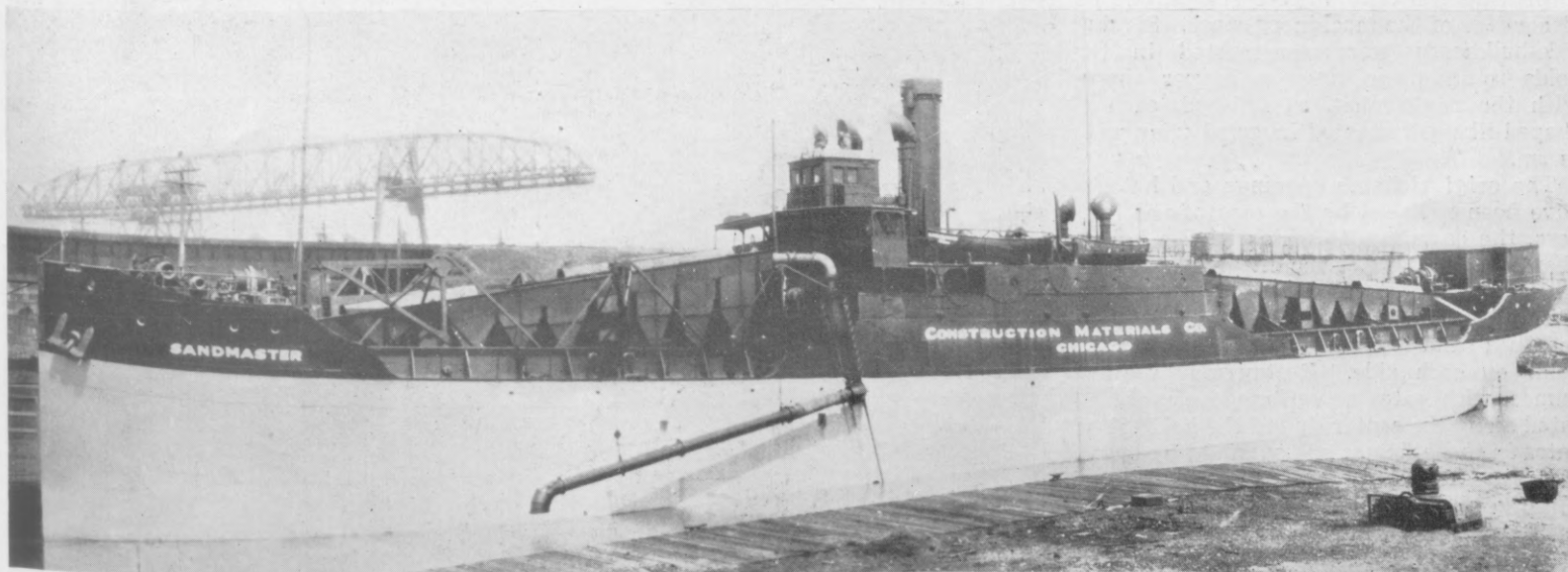
Characteristics of Sandmaster

Length overall	263 ft. 0 in.
Length, b.p.	251 ft. 0 in.
Breadth, molded	43 ft. 6 in.
Depth, molded	20 ft. 0 in.
Draft, load	18 ft. 0 in.
Capacity (hoppers)	3000 tons
Propulsion power	1000 s.hp.
Speed (light ship)	15 m.p.h.
Speed (loaded ship)	9 m.p.h.
Pumping power	800 hp.

On May 5, SANDMASTER was given a trial during which all of the machinery—propelling, pumping and auxiliary—proved

more satisfactory than anticipated. The following day the boat sailed for Chicago, where she was immediately placed in active service.

To convert successfully a freighter into a pipe-line hopper dredge is no light task, since it involves all sorts of problems of strength, stability and space arrangement. Furthermore, when to this conversion is added the work of changing from single to twin screw, the work becomes even more complicated. The "Lake" type of freighter has, however, many points to justify its selection for conversion. In the first place, the hull dimensions are such as to permit navigation of the Welland Canal locks, so that the completed dredge can be moved to any part of the world if necessary. In the second place the "three island" type of hull structure with holds forward and aft of the machinery space permits of ready transformation of the holds into hopper spaces, and in the third place, the forward and aft wells formed by the forecabin, bridge and poop erections permit of arrangement in these spaces of the pipe line discharges, the hopper tops, and the flume gate controls. It might be argued, of course, that with such a vessel irregular loading into the hoppers (i. e. more info, say, the forward hopper than into the aft



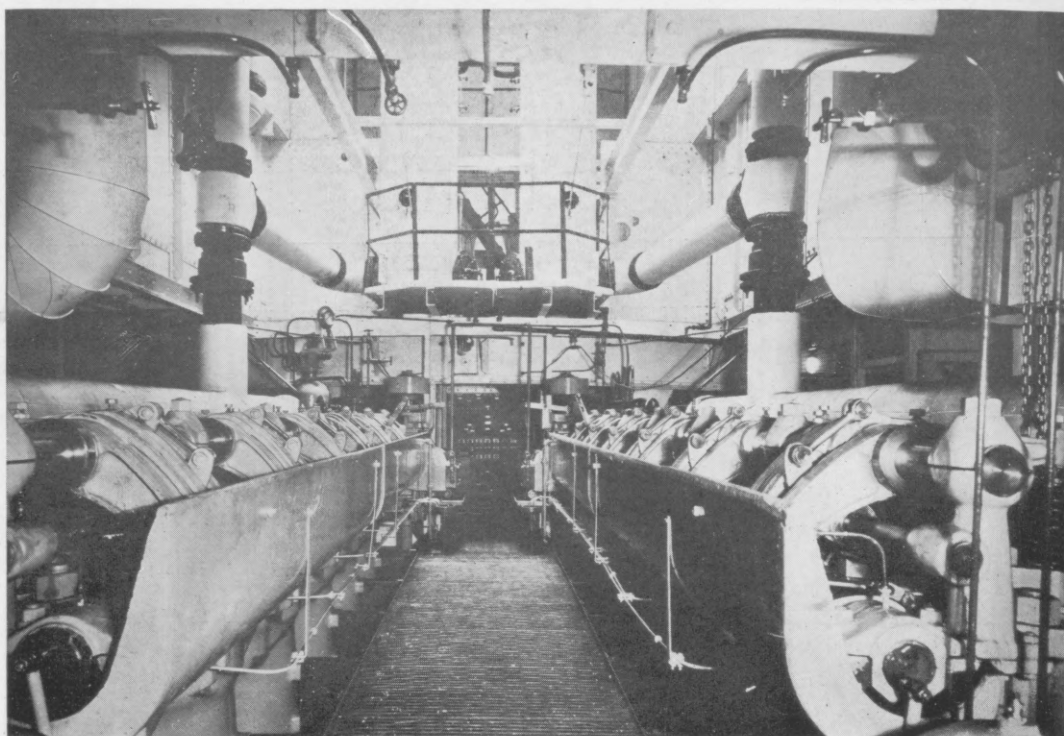
Ms. Sandmaster, formerly the freighter Lake Weir, has hoppers forward and aft of her machinery space capable of holding 3000 tons of sand

hopper) would cause severe loads in the ship's hull, as well as severe differences in trim. When light, too, there would be a heavy machinery weight amidships and negligible weight in the holds, which might set up heavy shear stresses in the hull structure. In SANDMASTER'S case, uneven loading is not liable to take place, owing to the conditions under which she operates, while longitudinal strength is amply provided by deep strong sides to the hopper tops. The fact, too, that Diesel-electric propulsion is adopted permits the main propelling motors to be arranged aft, thus not absorbing much space in the aft hopper. These reasons appear ample to justify the selection of a vessel of this type for conversion, rather than a vessel with machinery entirely aft or forward.

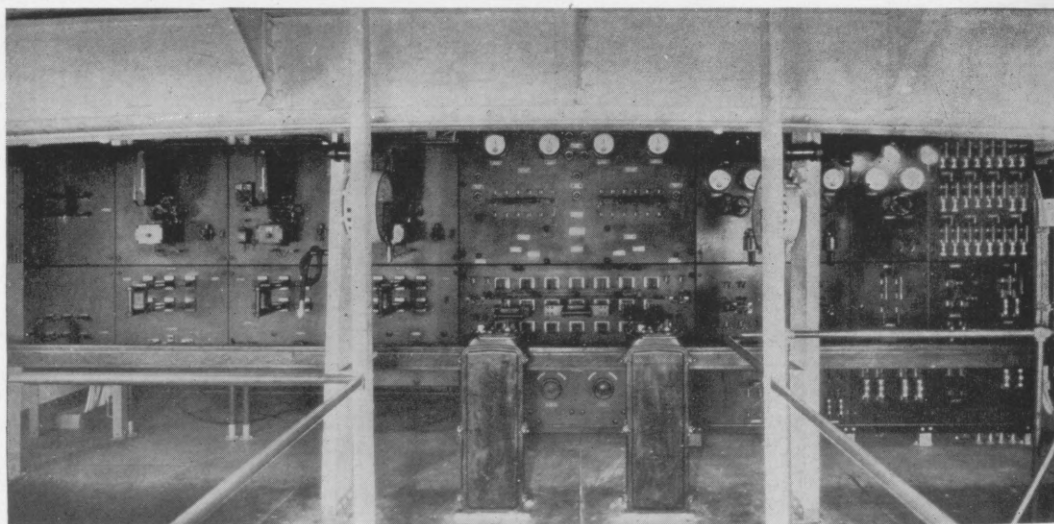
Work in converting the ship called for the removal of all the original machinery in the engine room, comprising a triple expansion steam unit developing 1200 i.h.p., together with auxiliaries, boilers, thrust, tunnel- and tail-shaft, fitting extra intercostals in the double bottom in way of the engine room, and substituting two 6-cylinder, 4-cycle Worthington Diesels of 600 hp. each at 200 r.p.m., together with two General Electric generators of 400 kw. and two exciters of 50 kw., and all necessary auxiliary pumps and units. The shaft tunnel was removed and the aperture in the aft engine room bulkhead filled in. A motor room, common to the two motors, and two new shaft tunnels and thrust recesses were constructed aft. The ship's side was cut for a certain distance aft below the waterline on either side to permit of the addition of bossings for the twin screws and, for this purpose also, spectacle frames were added. The original, conventional, single screw, stern frame forging was cut at the top and bottom, as the illustration indicates, in order to make room for a semi-balanced rudder, usual in Lake ships. In this case, the old rudder, of plate type, was adapted to the purpose and its area increased by the addition of a portion to the aft edge and the original forward edge. The stern frame orifice is partly filled by a plate secured to the forging by means of an angle bar, riveted to the plate and tapped to the forging. The original stern tube was not removed. The bulkheads separating, respectively, Nos. 1 & 2 and 3 & 4 holds were taken out to provide two clear hopper spaces, one on either side of the machinery space. Sloping side-bulkheads were constructed in the holds to give the latter a hopper shape, with the result that, as finished, each is shaped like a truncated inverted triangular prism.

The original hatch openings and hatches have been replaced by the tops of the hoppers, the coamings to which have a height about equal to that of the original bulwarks, now removed.

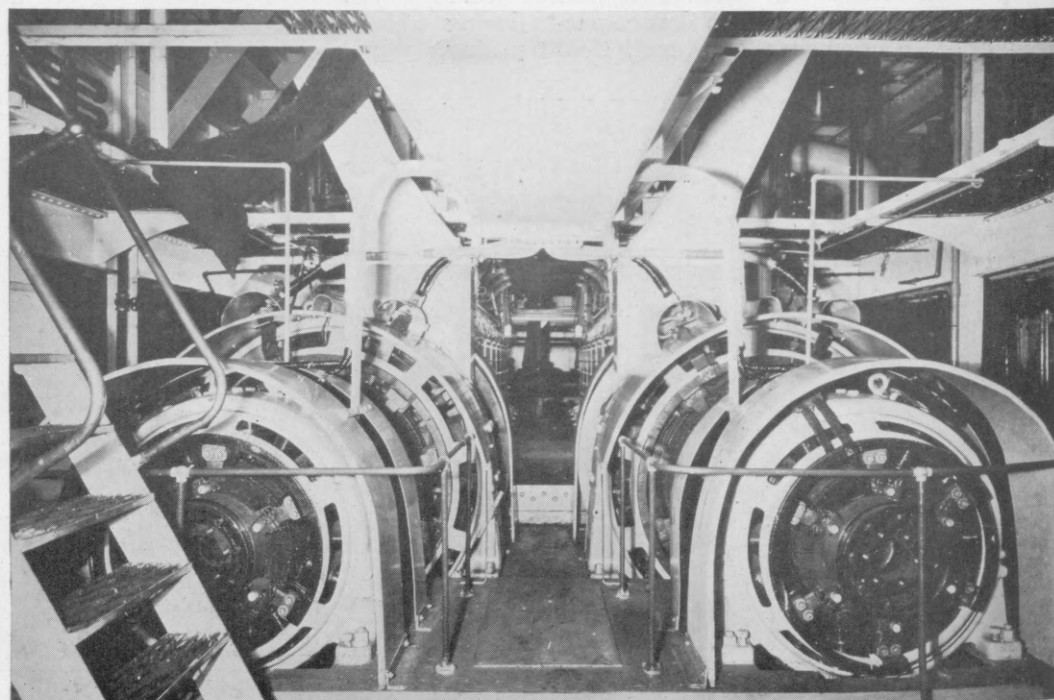
The forward and aft hoppers for holding the fluid sand and water are run above the holds on each side. Rectangular vertical flumes, with gates at various levels, are located along the center line of the holds. The gates in these flumes are operated by levers from a substantial wood stage, located slightly above the deck level. The fluid mixture of sand and water is pumped into the ship's hoppers through two adjustable suction pipes of 8 in. to 10 in. diameter, one on each side of the ship, arranged so that the ends connected to the hull both



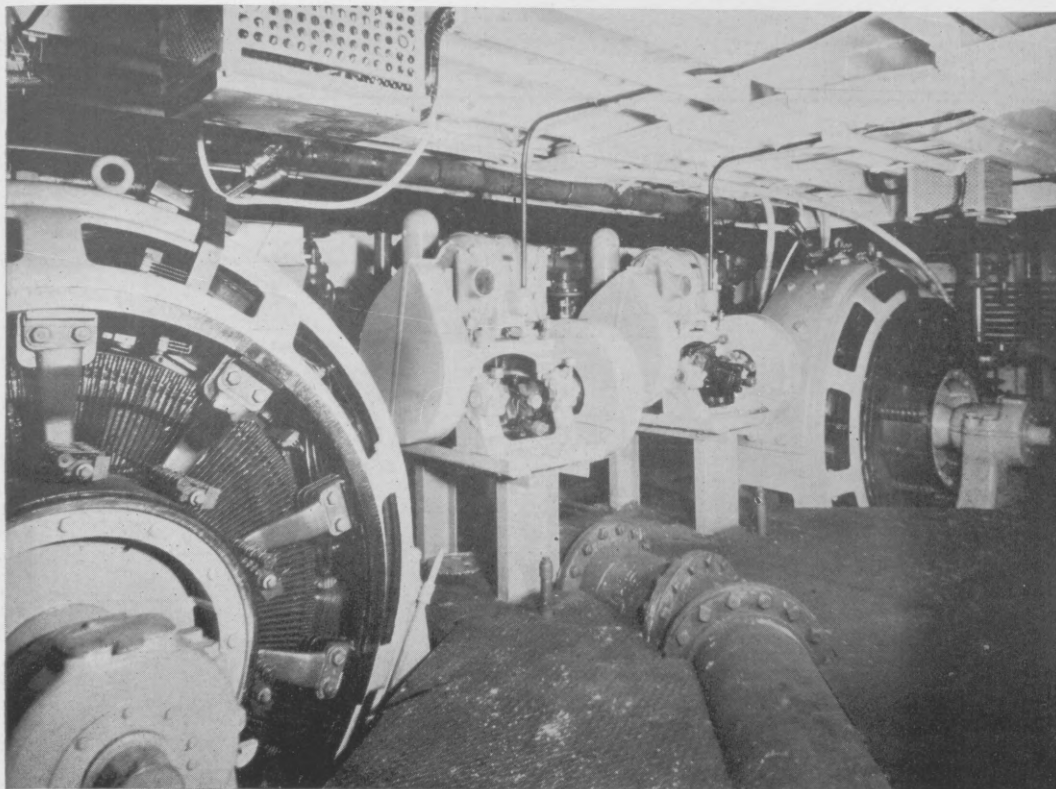
Two main Diesel driving generators are arranged in a fore and aft position



Main and auxiliary machinery can be controlled from the switchboard



Generators and exciter sets are direct coupled to two main 4-cycle Diesels



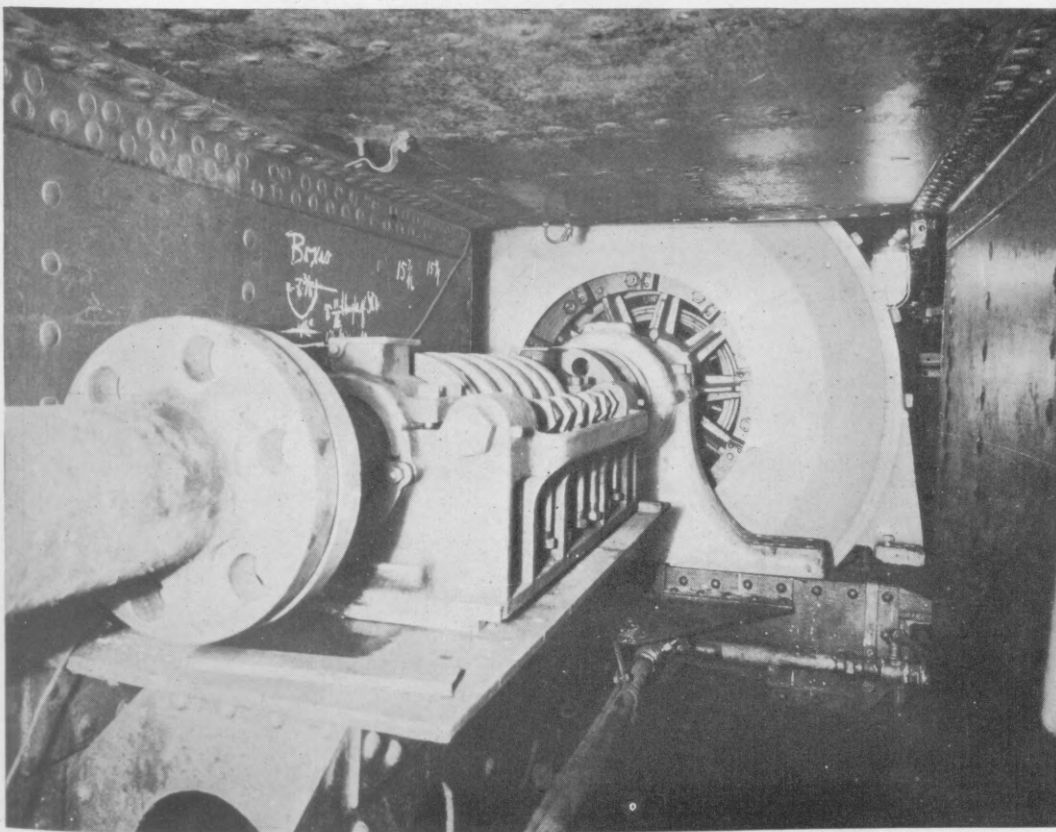
Two main propelling motors are located in a special engine room aft

slide in a vertical plane and swivel in a horizontal plane. Suctions, therefore, may be lowered or raised at any angle. This method of construction permits loading at varied depths of water, and takes care of listing of the vessel. When not in use, suction lines are secured on the deck.

Main engine equipment was supplied by the Worthington Pump and Machinery Corp., Buffalo, and consists of two 6-cylinder, 4-cycle Diesels developing 600 hp. apiece, and coupled up to a 410 kw. General Electric generator and a 50 kw. exciter, which acts as an auxiliary generator. These main generating units are located in the

fore and aft direction and toward the fore end of the machinery space.

They supply electric energy to two main propulsion motors and to two sand pump motors. Each propelling motor is rated at 500 hp. and is directly connected to one of the propeller shafts, driving through a multi-collar thrust. The two sand pumps have 18 in. discharges and are driven by 400 hp. electric motors through flexible geared coupling. On either side of the ship is located a Worthington 8-in. centrifugal jetting pump, driven by 125 hp. General Electric motor. These pumps have a capacity of 1750 gal. per minute at 75 lb.



Special tunnel has been constructed for each tail shaft and thrust block

pressure, and are used for pumping water into the sand when discharging, so as to provide the proper flow of sand.

Bunker capacity is 182 tons and the fuel oil for the engines is handled by two Worthington horizontal duplex pumps with 3 in. discharge opening. Cooling water pumps, bilge and ballast pump, sealing pump, fire pump, sanitary pump, fresh water pump and auxiliary cooling pump were also supplied by Worthington, who played a large part in designing and arranging the mechanical equipment of the vessel.

The two main generators supply a total of 800 kw., which is sufficient to take care of the power requirements of the two 500 hp. propelling motors when at sea, and the two large centrifugal sand pumps and jetting pumps when the vessel is handling sand. Power for the numerous auxiliaries on the ship is obtained from the two 50 kw. auxiliary generators mounted on an extension of the main generator and engine shaft.

A 60 b.hp. Worthington Diesel engine direct connected to an electric generator is provided to take care of the smaller power requirements while the vessel is in port and not unloading, in which case the main Diesel engines are shut down. This auxiliary engine is of the airless injection type.

Exhaust gas from the two Diesels is run through two waste heat boilers, which furnishes steam for heating, cooking, cleaning and other purposes about the ship. If, for any reason, no heat is desired on the boilers, the gas can be by-passed to the silencers, one for each engine.

Ward-Leonard system of generator field control is used, so that the motors driving the propellers and the sand pumps can be controlled either from the engine room or the pilot house. Exciting current for the main generators is supplied from the auxiliary generators mounted on an extension of the main generator shafts. This permits wide variations in the field strength of the main generating units to be obtained, permitting the generator voltage to be varied over wide limits without changing the speed of the main engines, governing of which is accomplished by regulating the fuel pump suction through a centrifugal governor of the Massey type.

The switchboard provides facilities for connecting either the propeller motors or the pump motors to one or both of the Diesel engine driven generators as occasion demands.

On the trial trip, SANDMASTER operated with less than 200 hp. per propeller, making 9.4 m.p.h. over a measured course. One of the 600 hp. Diesels easily supplied sufficient power to operate both propellers at full speed. The other engine-driven generator was in simultaneous operation, being used to supply energy for driving the sand pumps. During its trial the vessel was pumped with water and unloaded at sea, only a very slight list being noticeable.

Fuel oil is carried in a section of the double bottom, holding approximately 120 tons. In addition, there is a built-in deep tank for fuel oil, holding about as much more, the forward side of which is a part of the after engine room bulkhead. The exact capacity of this tank is 114 tons. Heating coils are provided around the fuel suction outlets. For daily service two 1000 gal. rectangular fuel tanks are used. There is also a 1000 gal. lubricating oil supply

tank and a 5000 gal. lubricating oil settling tank equipped with heater coils.

Ms. SANDMASTER represents the latest development of a type designed for important specialized work and her conversion embodies the experience of years in the handling and transport of sand. In order to make the method highly efficient, the proportion of sand to water has been adjusted with precision, to give the sand pumps all the solids they can handle at given heads without the danger of clogging pipe lines or the pumps.

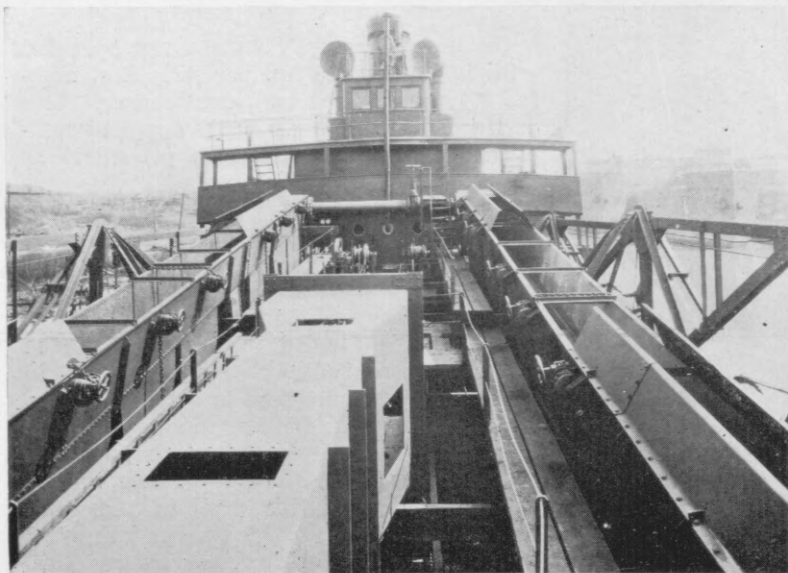
With steam equipment it was often necessary to stop to make the necessary adjustments to take care of the conditions under which the sand pumps would have to operate, no two jobs being alike in length of pipe line or height of fill. With Diesel-electric drive these adjustments can be made in a few minutes.



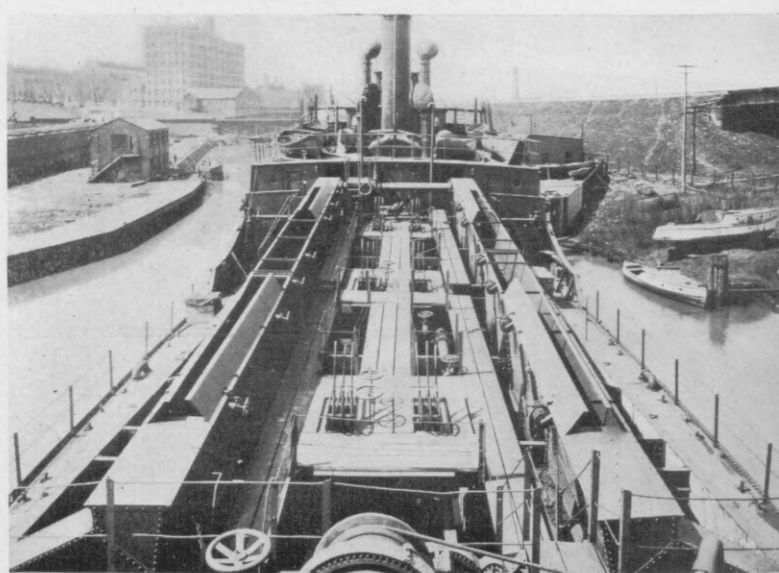
Sandmaster can navigate intricate waterways unaided owing to her electric control

Principal Machinery Equipment of Diesel-electric Dredge Sandmaster 251 ft. b.p., 3,000 tons capacity, 1000 b.hp.

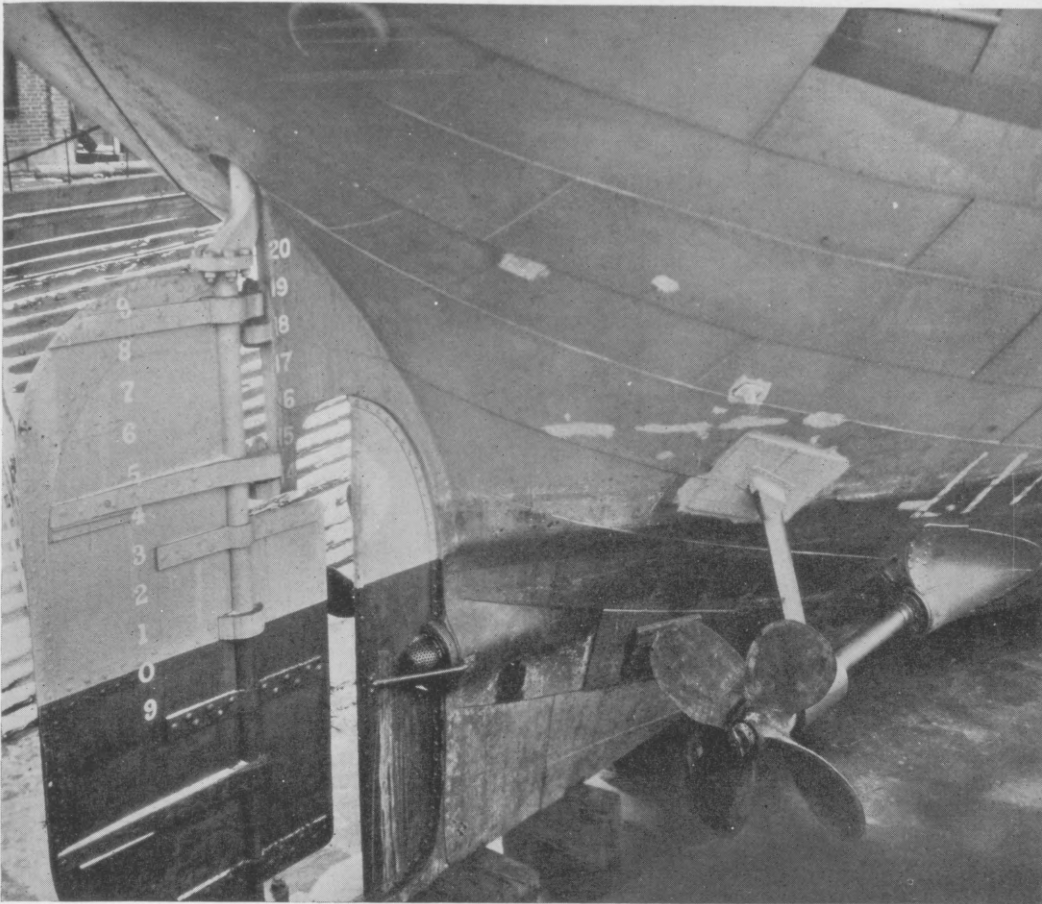
ITEM NO.	NAME	MAKE	QUANTITY	CHARACTERISTICS
1	Propelling motor.....	General Electric.....	2....	Open, single armature, 130 r.p.m., 240 volts, 500 b.hp.
2	Exciters	General Electric.....	2....	50 kw.
3	Main generators.....	General Electric.....	2....	410 kw. direct current, 240 volts, 200 r.p.m., each direct connected to one main engine.
4	Main generator engines..	Worthington	2....	6-cyl., single-acting, 200 r.p.m., 600 b.hp.
5	Sand pumps.....	Const. Materials Co....	2	Centrifugal, 18 in., 400 hp. motor, G. E. type.
6	Jetting pumps.....	Worthington	2....	Centrifugal, 8 in., 125 hp. motor, G. E. type, 1750 g.p.m. at 1700 r.p.m., 75 lb. pressure.
7	Bilge pump.....	Worthington	1....	Horizontal duplex, double-acting, 6 in. x 6 in., 5 hp. motor, G. E. type, 100 g.p.m.
8	Engine cooling pumps..	Worthington	2....	Centrifugal, 10 hp. motor, G. E. type, 250 g.p.m. at 1150 r.p.m., 50 ft. head.
9	Sealing pump.....	Worthington	1....	Horizontal duplex, 1/12 in. discharge—5 hp. motor, G. E. type, for sealing sand pumps.
10	Fire and general service pump.....	Worthington	1....	Centrifugal, 2-stage, 50 hp. motor, G. E. type, 100 lb. per sq. in., 500 g.p.m.
11	Fuel oil transfer pump..	Worthington	2....	Horizontal duplex, double-acting, 6 in. x 6 in., 5 hp. motor, G. E. type, 100 g.p.m.
12	Sanitary pump.....	Worthington	1....	Horizontal duplex, 1½ in., 5 hp. motor, G. E. type, connections to water service on shaft bearings, ice machine and distiller.
13	Boiler feed pump.....	Buffalo	1....	Centrifugal, 1 in., 3 hp. motor.
14	F. W. pump.....	Worthington	1....	Centrifugal, 1 in., 2 hp. motor.
15	Aux. cooling pump.....	Worthington	1....	Centrifugal, 1 in., 1 hp. motor.
16	Aux. generator.....	Engberg	1....	40 kw. direct current.
17	Aux. generator engine..	Worthington	1....	2-cyl., airless injection, single-acting, 60 hp.
18	Motor generators.....		2....	10 kw. direct current, 1700 r.p.m.
19	Oil purifiers.....	De Laval.....	2....	—



Pipe line discharges direct into forward hopper



Flume gates are controlled from platforms



Ms. Sandmaster's stern has been modified to meet Great Lakes practice and requirements

Diesel Tug Demonstration

DEMONSTRATING the maneuvering qualities of the Bethlehem airless injection oil engine, the motortug EUGENIA M. MORAN recently made a number of trial runs in New York harbor. These trial runs served the dual purpose of showing the qualities and characteristics of this 2-cycle airless injection type of engine as well as indicating what can be done in handling a towboat in which a Diesel engine of direct reversible type is coupled to the propeller without the intermediary of any reduction gear either mechanical or electrical.

EUGENIA M. MORAN is Moran Towing and Transportation Co.'s first Diesel tug and her conversion to Diesel power was made in 1923. She is reported to have

given satisfaction to her owners. In fact, Mr. Moran himself considers it is merely a matter of time before all private towboat owners definitely go over to Diesel drive. When replacements become due the Diesel engine will be selected for re-powering in practically every case.

Eugenia M. Moran Characteristics

Length on waterline.....	81 ft. 3 in.
Beam molded.....	20 ft. 6 in.
Draft	10 ft.
Gross tonnage.....	107.59 tons
Power	320 s.hp.
Speed (light).....	8 knots

The original steam plant fitted when the ship was new in 1919, consisting of a compound engine and a pipe boiler having 125

lb. per sq. in. working pressure, was removed in 1923 and replaced by a Trout Diesel of 320 b.hp. This unit was superceded last Fall by a 4-cylinder direct reversible Bethlehem airless injection Diesel of the same bore and stroke (14½ in. bore, 21 in. stroke) with attached scavenging pump, developing 320 s.hp. at 220 r.p.m. This engine drives a 3-bladed semi-steel wheel, 7 ft. diameter by 7 ft. pitch. Dual control levers are installed so that the engine can be maneuvered from the top grating as well as the engine room floor. The vessel maneuvers rapidly and efficiently. Starting air at 350 lb. per sq. in. pressure is carried in a battery of seven tanks 24 in. diameter and 72 in. long, the pressure being maintained by an attached 2-stage air compressor.

EUGENIA M. MORAN carries 6000 gal. of fuel oil in a single tank 8 ft. by 11 ft. by 9.5 ft., giving over 12 days' operation at full power without refuelling.

A new motorship to be fitted with Scott-Still engines of larger size than those on the Alfred Holt motorship DOLIUS and of improved design has recently been ordered from Scott's of Greenock by the same owners. The vessel will have an overall length of 449 ft., with a beam of 54 ft. 6 in., and a depth of 32 ft. 9 in. Her displacement will be about 12,500 tons, with a gross tonnage of about 6500 tons.

The speed of the ship at sea is to be 14½ knots, and her twin-screw machinery is to develop about 5000 b.hp. at a normal speed of 102 r.p.m. Each engine will have five single-acting 27 in. diameter combustion cylinders and two double-acting 24 in. steam cylinders. All the cylinders will have a common stroke of 45 in.

On a recent run from Liverpool to Port Said on her sixth voyage to the East, DOLIUS maintained an average speed of 11.53 knots, with a displacement of 11,100 tons on a fuel consumption of 8.67 tons of oil per day, or 0.363 lb. per b.hp. per hour for all purposes. This is stated to be a performance which has been unequalled in the record of ocean ship propulsion.

Vineyard Ship Building Co., Milford, Del., offers for sale a 77 ft. Diesel towboat equipped with a 360 hp. Fairbanks-Morse engine.

J. W. Van Dyke's Cruise

ATOTAL distance of 15,000 miles without refuelling will have been performed by J. W. VAN DYKE, large Diesel-electric tanker owned by the Atlantic Refining Co., when she returns to this country. The vessel left Philadelphia with a cargo of gasoline and petroleum products for Rio de Janeiro, Brazil, and Durban, South Africa.

J. W. VAN DYKE has pilot house control and it is estimated that at the completion of this trip she will have navigated a total distance of 80,000 miles under this system of operation. Three 6-cylinder 840 hp. Ingersoll-Rand engines drive Westinghouse generators and supply current for the propulsion equipment on the ship. The vessel was originally the ALLENTOWN, a geared turbine tanker owned by the U. S.

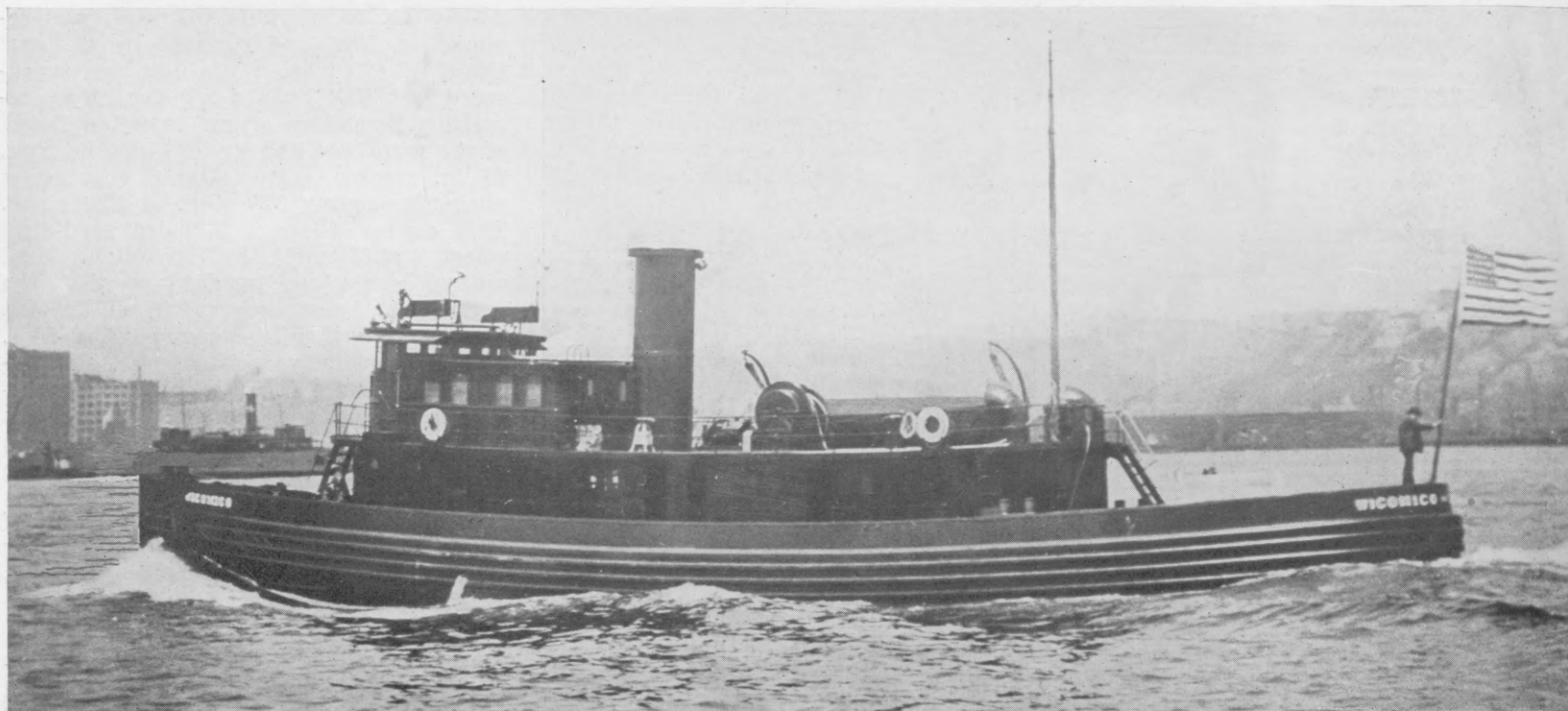
Shipping Board. After conversion to Diesel-electric drive her cruising radius was increased over 5000 miles. As a steamer she could cruise 11,000 miles without refueling; as a Diesel-electric ship she can cruise 16,000 miles. The cargo capacity of the vessel was also increased by more than 5000 bbl.

Atlantic Refining Company now plans to convert three more tankers to Diesel-electric drive. When this is done they will have a fleet of eight Diesel-electric ships all equipped with Ingersoll-Rand engines driving generators. Their present fleet comprises the tanker BRILLIANT, the tugs VAN DYKE I, VAN DYKE II and VAN DYKE III and the tanker J. W. VAN DYKE. The three tugs mentioned above were the first Diesel-electric tugs to be used in long distant coastwise towing, and the tanker J. W. VAN DYKE was the first Diesel-electric ship

to pass through the Panama Canal when she made two voyages to San Pedro. The vessel has also been actively engaged in the coastwise trade between Philadelphia and Port Arthur, and Texas City.

Shipping Board has authorized the offering for sale of the steam driven tankers HAMPTON ROADS, and CECIL COUNTY, 7640 tons gross, DISTRICT OF COLUMBIA, 7640 tons gross, and CHESTNUT HILL and BRANDYWINE, 4935 tons gross, for conversion to Diesel-electric drive.

Confirmation of a rumor which has been rife for several months was given by the announcement that Vickers Ltd., Barrow-in-Furness are to construct both double-acting and single-acting 2-cycle Diesels under the patents and designs of the Maschinenfabrik-Augsburg-Nurnberg.



Wicomico will tow a 334 ft. car float loaded with 26 freight cars, her main motor developing 575 s.hp. at 125 r.p.m.

P. R. R. Operating 4 Diesel-Electric Tugs

Wicomico is on Cape Charles-Norfolk Ferry—P. R. R. 18 and 26
Join P. R. R. 16 in New York

COMPLETION of the Pennsylvania Railroad's Diesel-electric towboat WICOMICO brings the total number of towboats now in the service of this company operating on the Diesel-electric system to four. WICOMICO, P.R.R. 18, and P.R.R. 26 went on service on May 8, May 10, and June 19th respectively while P.R.R. 16—pioneer ship of this fleet—was commissioned on July 14, 1924. Two small tugs are now under construction and their completion will bring the P.R.R. Diesel-electric fleet up to 6. The small tugs have been specially designed for the Marine Power Department of the Pennsylvania Railroad, for handling carfloats from one berth to

another and are known as "Drill" tugs. They are double ended with one wheelhouse in the superstructure centre.

P.R.R. 16 differs in detail from P.R.R. 18 and 26, which are sister ships, and these 3 ships are now engaged in towing barges and floats between various piers and terminals in New York harbor.

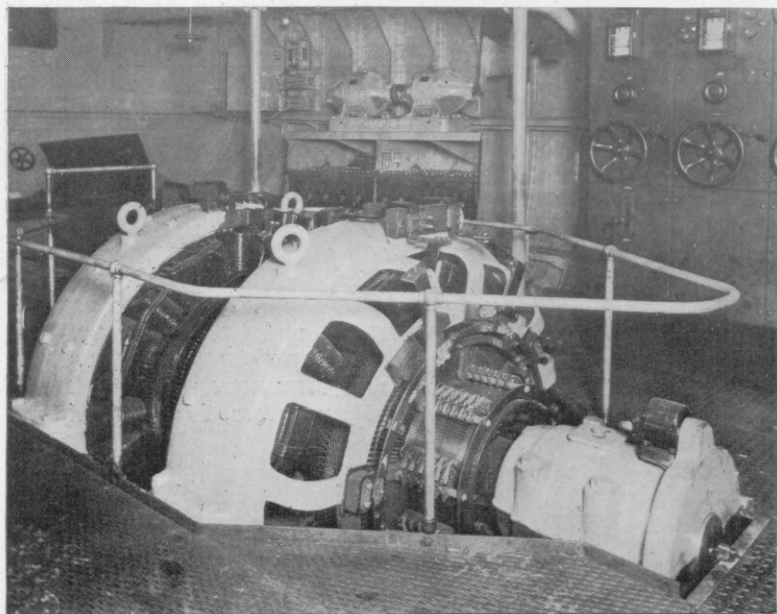
Characteristics of Wicomico

Length, overall	122 ft. 0 in.
Beam, molded	24 ft. 0 in.
Draft (mean)	11 ft. 0 in.
Speed (max.)	13.2 m.p.h.
Main motor (average)	575 s.hp.

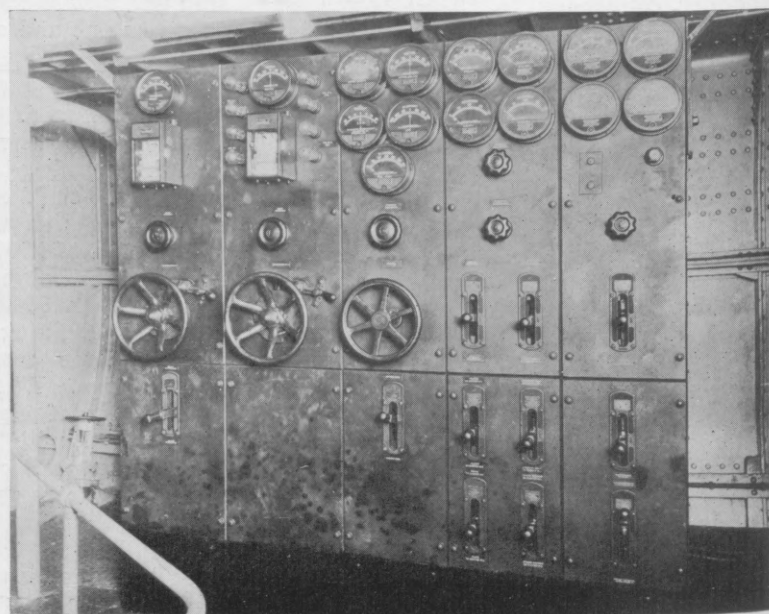
WICOMICO has been specially designed and built for the Norfolk—Cape Charles

freight ferry service of the Pennsylvania Railroad and the vessel is of particular interest on this account, since the duty is one of a particularly arduous type which has been maintained hitherto entirely by steam towboats.

The hull including the superstructure, pilot house and fenders is constructed entirely of steel. The fenders are of a special type evolved and used by the Pennsylvania Railroad on their towboats, and other similar ships, and consist of three parallel strakes of plating 12.175 in. finished width furnaceed to be convex outward from the ship's side, the hollow space so formed being filled with cement. Their vertical spacing



Propelling motor is double armature type



Dead front switchboard has emergency speed control

is 4 in. edge to edge and they are riveted to the sheer strake. WICOMICO, structurally, follows normal towboat practice having a bar keel, with reverse frame worked along the top of the floor plates. A slight difference occurs in the stern, however, which has a very deep vertical counter. Sun Ship-

are separately excited from one of the exciters. The main motor fields are excited at a constant value. The main generator excitation is controlled either by the reversing field rheostat operated by the hand wheel on the third panel from the left of the main switchboard in the engine room,

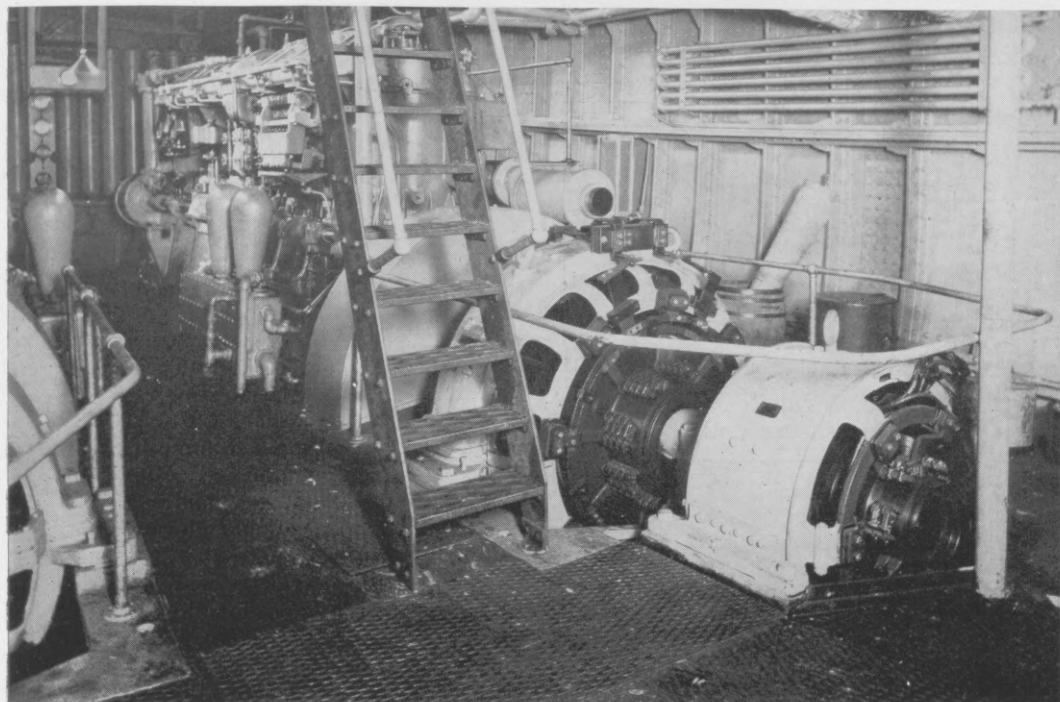
the value and direction of the applied voltage. It will thus be seen that all maneuvering and speed control of the propelling motor is controlled by operation of the generator reversing field rheostat.

The pilot house control station is normally used. The control handles in the pilot house are so arranged that the vertical position is the off position, a forward movement of the handle causing forward rotation, and an astern motion causing reverse rotation. The control points are so finely divided as to obtain any desired refinement of control from stop to full ahead or astern.

The instruments on the main board indicate the voltage and current in the various machines, as well as the revolutions of the propelling motor. The instrument board in the pilot house indicates the propulsion circuit voltage and current and the speed of the propelling motor.

Two control stands, similar to ordinary engine room telegraphs without the dial face, are arranged in WICOMICO's pilot house at the forward end and the levers act in unison. Pilot house control is, duplicated in the engine room for emergency purposes, and the main switchboard and control panel is on the port side of the engine room aft at floor plate level.

The main switchboard is of dead front type, all wiring, buses, switches, etc., being mounted back of the board, providing the maximum of safety from shock. The hand wheels on the two panels at the left of the board operate the main generator set-up switches, which connect the generators to the main propulsion circuit, or to the fire pump circuit, the hand wheels being mechanically and electrically interlocked so that the switches cannot be opened under power.



Wicomico's main generator sets have each a 6-cylinder Diesel drive

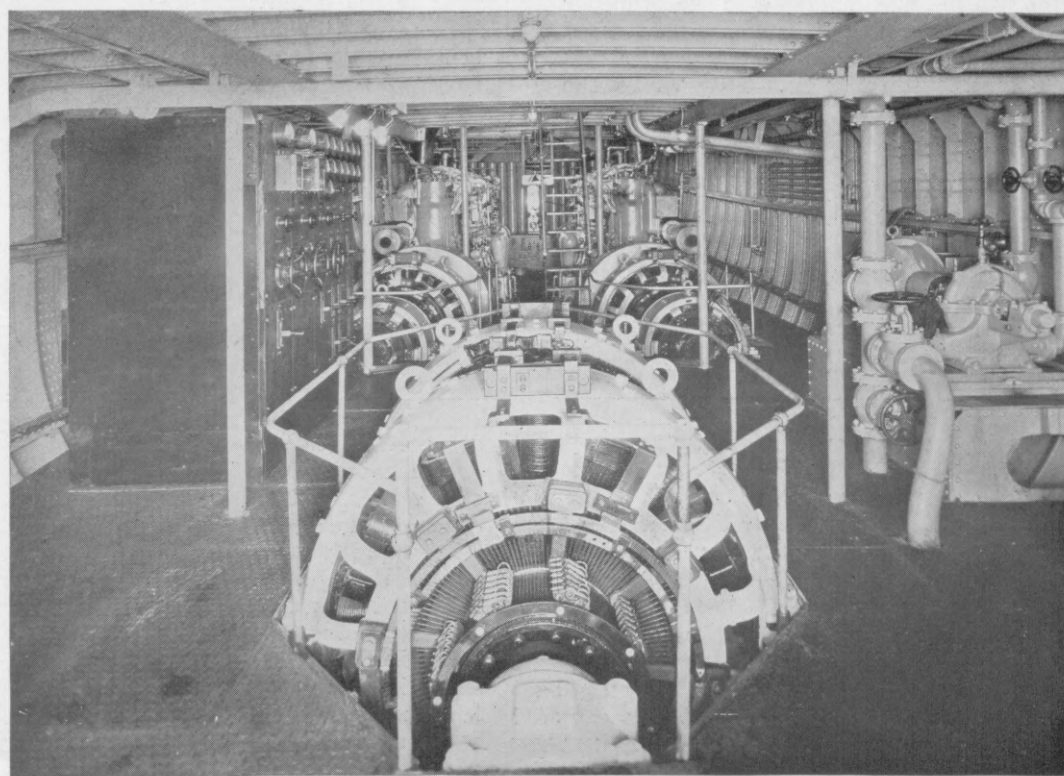
building Company, Chester, Pa., constructed the hull.

The main Diesel engines were supplied by the Winton Engine Company, Cleveland Ohio while the whole of the generator sets, motors, and other electrical equipment were furnished by the Westinghouse Electric and Manufacturing Company. The hull was delivered to the Hoboken Shops of the Pennsylvania Railroad where all the main and auxiliary machinery was assembled and installed. Two 6-cylinder 375 hp. Winton Diesel engines (cylinder diameter 14 in. by 18 in. stroke) of non-reversible type are each coupled to a Westinghouse direct current shunt wound generator, rated at 235 kw., at 250 volts, and a 35 kw. compound wound exciter. The engines are started by air. Both engines are automatically governed. The main generating sets are arranged in the body of the engine room, and a row of starting air bottles is attached vertically to the forward engine room bulkhead. Exhaust from the two Diesels is taken up into a squat stack on the superstructure immediately abaft the pilot house and just forward of a powerful automatic towing winch. The whistle on the stack is actuated by compressed air taken from the second stage of the air compressor on the main engines.

The 2 generators in series furnish current for the propelling motor, while the exciters, in addition to excitation, furnish current for all the auxiliaries on the boat. The main propelling motor is of shunt wound, double armature type rated at 575 s.h.p. at 500 volts and 125 r.p.m. It turns a bronze wheel 9 ft. 6 in. diameter by 9 ft. 6 in. pitch.

Westinghouse variable voltage system of control is used for the propelling equipment. The main motor and generator fields

or by the reversing rheostat operated from either of the two control pedestals in the pilot house. The generator fields are varied from zero to a maximum in either direction, and since the generators are driven at a constant speed, the generated



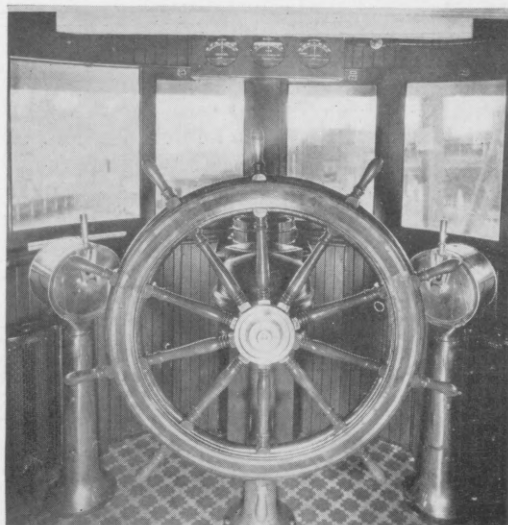
Wicomico's Diesel-electric power plant provides a neat engine room layout

voltage varies from zero to a maximum in either direction directly with the value of the excitation. Since the motor fields are constantly excited, the speed and direction of rotation of the motor will depend upon

Electricity is used for lighting, for which purpose there is a small motor generator in the engine room, and heating, for which purpose there are electric radiators arranged in various parts of the ship—

in engine room, pilot house and living quarters—for refrigeration, and for cooking, an Edison Electric Hotpoint stove being fitted for this purpose. Electricity also drives all the auxiliary machinery which includes the usual service pumps and a specially powerful centrifugal fire fighting pump capable of serving a monitor, on top of the pilot house. This pump is located on the starboard side of the engine room aft. Arrangements are made whereby when WICOMICO is tied up in cold weather with no generators running, steam can be fed from a shore connection into specially arranged radiators.

Mention has already been made of the powerful automatic towing winch arranged on the superstructure abaft the stack. This is an important unit of equipment in the service in which WICOMICO will be engaged. It is arranged to take in slack and pay out on the towing hawser as required. When towing, during preliminary trials, a stress on the towing hawser of 10,700 lb. was reg-



Wicomico's pilot house control

through a pedestal-mounted master controller in the pilot house and the control

control is actuated by a standard steering wheel by the use of which the pilot can at all times have direct control on the steering gear and either of the propulsion control pedestals at the same time. A rudder angle indicator is incorporated in the casing of the master controller.

An idea of the duty which WICOMICO will be called upon to perform will be obtained from the fact that the course over which car floats are towed from Cape Charles to Port Norfolk—is 36 miles long. Eight tugs and 10 steel car floats are regularly engaged in moving freight over this course. These tugs and barges are operated night and day all year round without interruptions other than those occasioned by storms. A tug and barge unit usually averages four trips daily, or 144 miles actual towing. The tow, in fine weather, takes four hours. This ferry has handled as many as 1247 cars in a 24-hour period, representing 48 trips, or an average of 124 cars and 4.86 trips per tug and float. The

Details of Machinery Equipment of Diesel-electric Towboat WICOMICO 122 ft. o.a., 575 s.hp.

ITEM NO.	NAME	MAKE	QUANTITY	CHARACTERISTICS
1	Propelling motor.....	Westinghouse	1	Open, double armature, 125 r.p.m., 250 volts per armature, 575 s.hp.
2	Propeller		1	Bronze, 9 ft. 6 in. diameter x 9 ft. 6 in. pitch.
3	Switchboard	Westinghouse	1	Ebony asbestoes, 5 panel.
4	Main Engines.....	Winton	2	6-cyl., single acting, 14 in. x 18 in., 260 r.p.m., 375 s.hp. each.
5	Main Generators	Westinghouse	2	235 kw. direct current, 250 volt, 260 r.p.m., each direct connected to one main engine.
6	Exciters	Westinghouse	2	35 kw. direct current, 250 volt, 260 r.p.m., each attached to one main generator.
7	Fire Pump	Gould Mfg. Co.	1	Centrifugal, 60 hp. motor, 1750 r.p.m.
8	Bilge Pumps	Blackmer	2	Positive displacement, rotary, 3 hp. motor, 1725 r.p.m.
9	Electric Towing Winch....	Westinghouse	1	40 hp. motor, 480 r.p.m., solenoid brake and cam operated reversing controller.
10	Windlass		1	Motor mounted below deck.
11	Galley Range	Edison Hotpoint	1	
12	Motor Generator.....	Westinghouse	1	3½ kw. for supplying lighting current direct or for charging two sets of 32-volt Edison lighting batteries.

istered at a speed of 9.20 m.p.h. at which time 645 hp. was delivered to the propeller shaft at 121 r.p.m. The maximum speed attained when running, 13.2 m.p.h. was registered with 635 hp. delivered to the propeller shaft at 130 r.p.m.

The steering gear has worm-gear drive as standardized on P. R. R. tugboats. The gear is motor driven by a 7½ hp., 500 r.p.m., 230 volt drip-proof self-ventilated Westinghouse marine motor, on the shaft of which is also mounted an enclosed shoe type solenoid brake. Control of the motor is designed on the non-follow-up principle

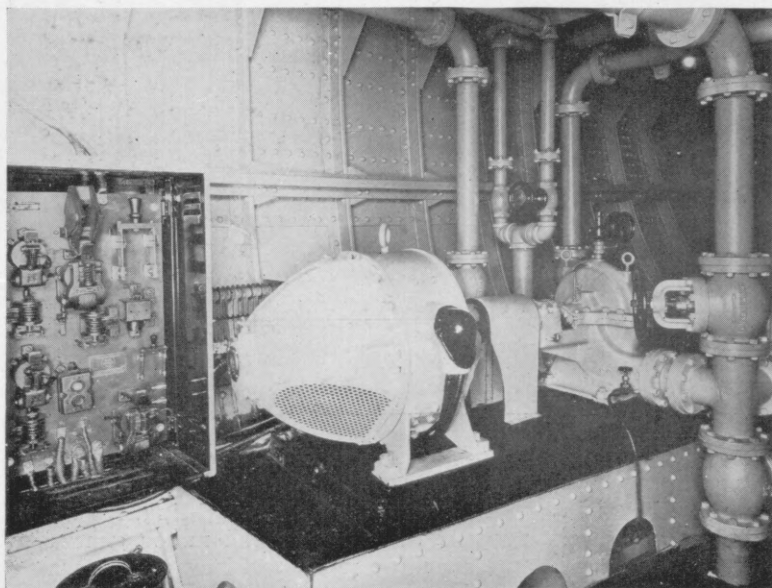
panel mounted in a drip-proof cabinet adjacent to the motor.

The control provides one running point for each direction of operation of the rudder, with overtravel of the rudder limited in each direction by a limit switch. A feature of the control is the inclusion of two additional points of control, one for each direction of the rudder whereby a slower or creeping speed of rudder travel can be obtained. This provides a little greater refinement of control and enables the pilot to plot a straighter course than could otherwise be obtained. The master

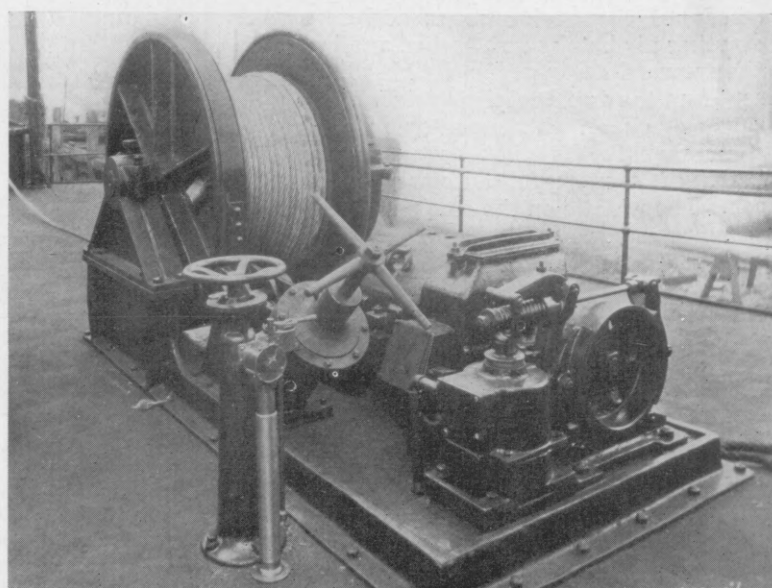
ferry handles, in large quantities, lumber, perishable fruits and vegetables moving to the markets of Philadelphia, New York and New England from the South.

The type of car float standard in this service is of all steel construction, 334 ft. long by 50 ft. beam, with 4 parallel tracks. Usually 26 cars are handled per float.

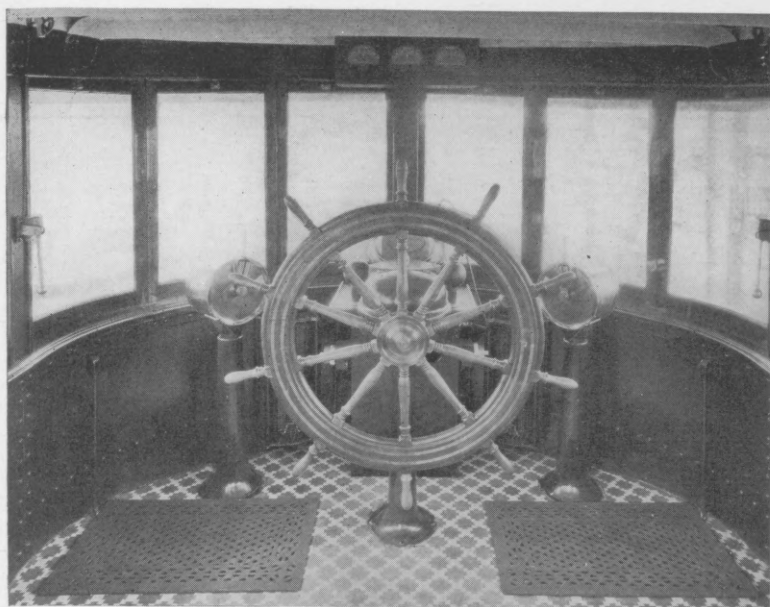
The floats are surmounted by steel bridges on which is located the steam steering apparatus, each float being entirely under the control of its own crew at all times, except as to propelling power which is furnished by the tug. The floats are double ended and are



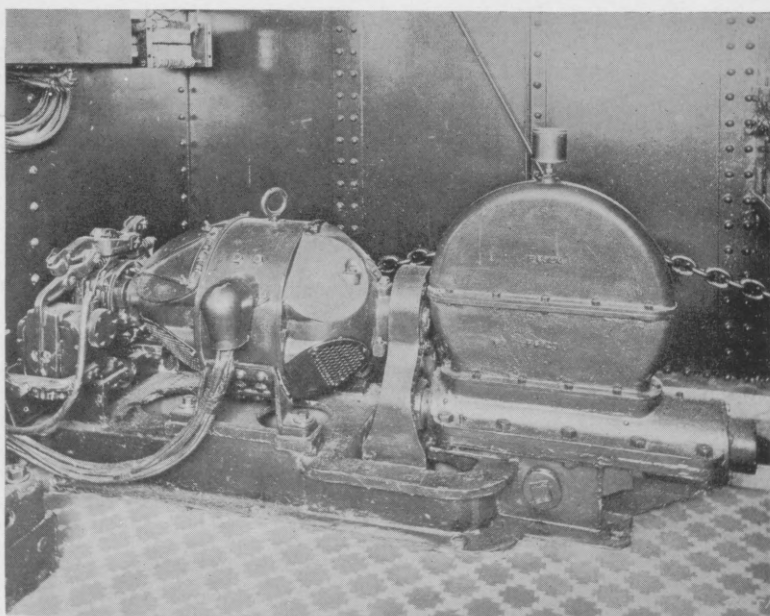
Fire-fighting pump is centrifugal



Towing winch is automatic



P. R. R. 26 has large pilot house



Electric steering gear is accessible

towed by steel cables 800 ft. in length. One tug handles one float only and the cars are moved on and off the floats at terminals with shifting engines over single span floating transfer bridges hinged to the dock at one end and resting on pontoons so that they rise and fall with the tide.

Characteristics of P. R. R. 18 and 26

Length overall.....	105 ft. 0 in.
Beam molded.....	24 ft. 0 in.
Draft	12 ft. 0 in.
Power (max).....	646 s.h.p.
R.p.m. (max).....	133
Speed (max).....	13.52 m.p.h.
Speed (towing).....	6.36 m.p.h.

P. R. R. 18 and 26 are slight modifications of P. R. R. 16. The arrangement and powering of the engines and generators is the same, viz.: two 6-cylinder Winton Diesels driving Westinghouse d.c. generators rated at 235 kw. and 250 volts, each generator having attached a 25 kw. compound exciter. The exciters, in addition to excitation furnish current for all the auxiliaries on the ship.

The main propelling motor is of shunt wound double armature type rated at 575 s.h.p. at 500 volts and 125 r.p.m. It drives a bronze wheel 9 ft. 6 in. diameter and 9 ft.

6 in. pitch. Ward-Leonard control for the main motor is adopted, 2 controllers of engine room telegraph type being arranged in the wheel house while control can also be carried out from the switchboard panel if necessary. This is arranged at main deck level in the engine casing.

P. R. R. 18 and 26 have a length overall of 105 ft. 0 in., a beam molded of 24 ft. 0 in. and a draft of 12 ft. 0 in. The hulls were built by the Newport News Shipbuilding Company, Newport, News, Va., the Diesel engines were supplied by the Winton Engine Company while the generators, motors, and other electrical equipment are of Westinghouse manufacture. These parts were assembled and installed and the boats were fitted out at the Hoboken shops as in the case of the WICOMICO.

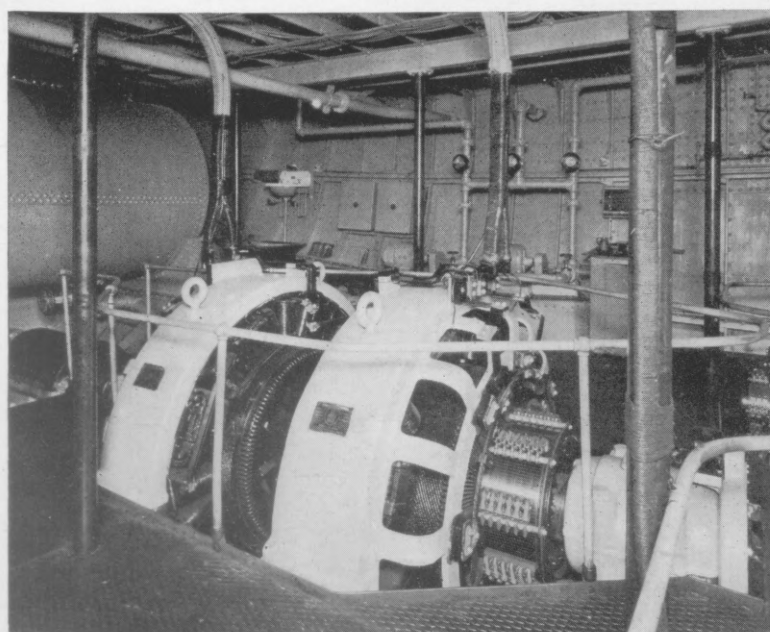
These two towboats attained an average maximum speed of 13.52 miles per hour with 646 s.h.p. and 133 r.p.m. When towing, P. R. R. 16 developed a speed of about 6.36 m.p.h. with a stress on the towing hawser of 15,180 lb. at which time 629 hp. was delivered to the shaft at 117 r.p.m.

Two Nelseco Diesels of 300 s.h.p. each at 260 r.p.m. are used to power the 7500 bbl.

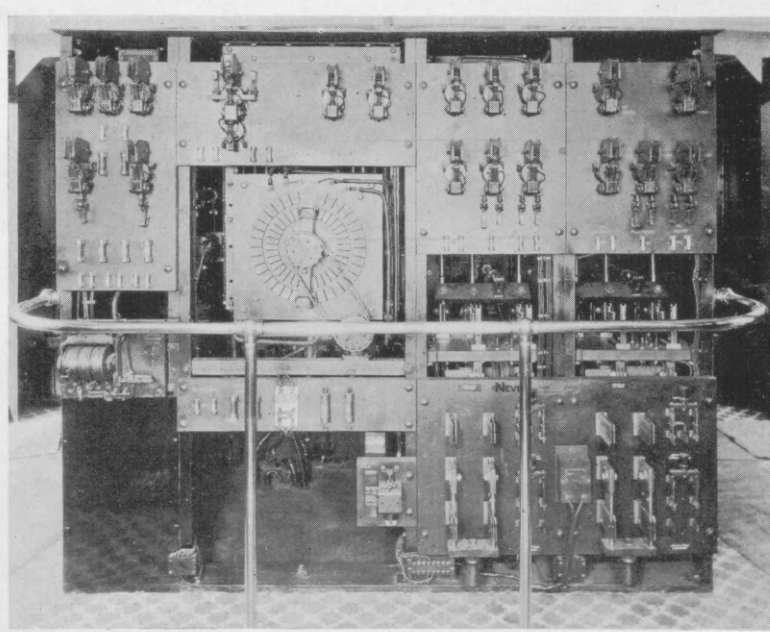
tanker B. B. MCCALL, first motor tanker to operate out of Buffalo, owned by McCall Brothers Shipping Company. Ms. B. B. MCCALL was built in 1915 as SS. PULOE BRANI at the Admiralty docks, Chatham, England, and during the war served as an oil supply ship to the North Sea Fleet operating from Scapa Flow. The vessel was subsequently purchased by McCall Brothers for \$500,000.

Substitution of Diesel drive increased her power from 480 to 600 horsepower and her speed to 12 knots. She carries two auxiliary engines of Diesel type of 100 hp. each, which are connected with generators.

Shipping Board is taking an interesting constructional step in its intention to modify the lines of a number of freighters so that, after Dieselization, they can be depended upon to make 12 knots minimum speed on service. The Board believes that the fining of the lines of these ships forward and aft of the parallel middle body could be accomplished at a moderate cost. Incidentally if it decreases the cargo capacity of the ships, as steamers, the space so lost should be regained by the smaller Diesel machinery spaces.



P. R. R. 26 develops 575 s.h.p. at 125 r.p.m.



Switchboard back shows dead front construction

Fast Motorships in Far Eastern Trade

Prince Line's New 14½ Knotters Cut Time from New York to Far East by 7 Days

FURNESS WITHY'S five new 10,000 ton, 14½, knot twin screw cargo motorliners for the Prince Line New York-Far Eastern service definitely mark the advent of the fast motor freighter which must eventually run the slower and more expensive steamer out of business. Sailing from New York on March 25, MALAYAN PRINCE, first of five new German-built motor cargo liners reached Yokohama on schedule in the reasonable time of 35 days. Keeping well within her schedule she returned to New York on July 20, thus completing her maiden round-the-world trip in 119 days. The average speed for the whole distance works out at slightly under 14 knots which is very reasonable when the vicissitudes of a trade such as that in which MALAYAN PRINCE is engaged are taken into account. On her trial trip, when light, a speed of nearly 16 knots was recorded and at certain periods of the maiden voyage 15 knots were logged. Weather conditions at other periods were responsible for reducing the speed to 13 knots. Monsoon, typhoon, Atlantic gale—these are all factors which have to be taken into account when fixing the maximum sea speed for a ship for this branch of Far Eastern trade.

MALAYAN PRINCE ran her trial trip and left almost immediately for New York where, after a stay of only a few days, she commenced her maiden voyage calling at the ports shown in the schedule and staying only sufficient time to load and discharge cargo. Except for attention to minor repairs therefore, there has been no chance of taking down the main engines until her return to New York. They have run steadily

with an average all-purpose fuel consumption of 25 to 25.7 tons of Diesel fuel oil and 37 gallons of lubricating oil per day. This, of course, is a maiden voyage result which will without question be improved on the next voyage. It is also anticipated that the schedule will be shortened. JAVANESE PRINCE, the second ship, left New York on April 20 arriving at Yokohama 2 days ahead of her schedule and about 7 days ahead of steamers employed on this service, until the advent of the new motorships. The remaining units of the new fleet left at regular intervals after this and are now all in service.

Chief Characteristics of Prince Line Motorships

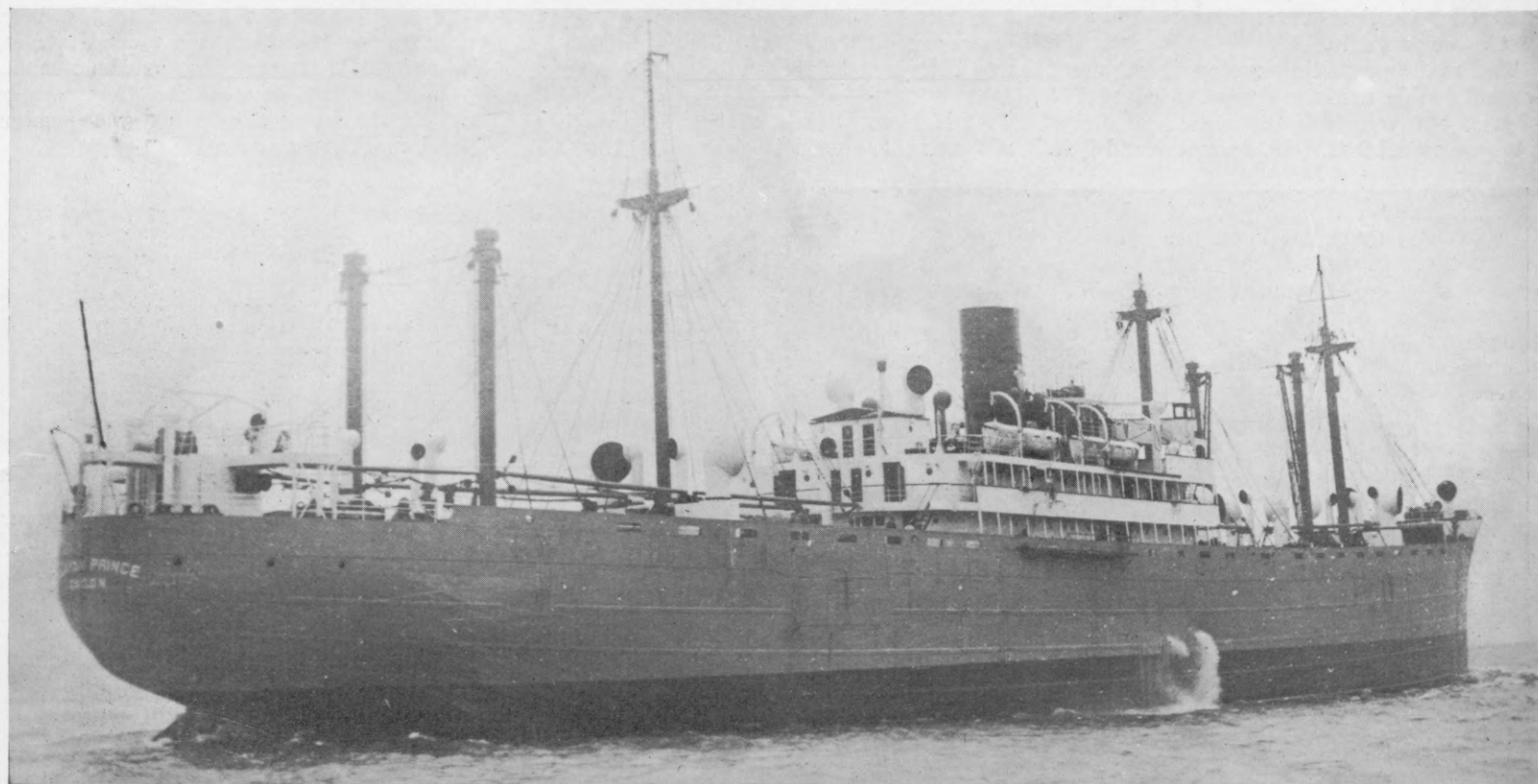
Length, b.p.....	441 ft. 9 in.
Beam, molded.....	60 ft. 0 in.
Depth, to shelter deck.....	42 ft. 3 in.
Draught.....	27 ft. 6 in.
Gross register.....	6,376 tons
Deadweight capacity.....	10,000 tons
No. of holds.....	5 & 1 deep tank
Speed (loaded).....	14½ knots
Length of motor room.....	59 ft. 6 in.

Their designed loaded speed of about 14½ knots is faster by 2½ to 3 knots than any other motorship at present employed in the New York-Far Eastern trade and faster than the majority of steamers.

Considerable interest was manifest when Furness Withy last year, passing over British shipyards on account of their higher bids, went to the Deutsche Werft, Hamburg, with orders to construct five high class freight carrying motorships of 10,000 tons

deadweight capacity and 14½ knots speed. This speed in itself was something of an innovation because even as recently as last year very few purely freight motor vessels of over 12½ knots speed were being built. It was realized by the owners, however, that shippers at the present time in certain trades are demanding speedy transit for their freight, and that generally speaking the faster ship gets the better class freight to handle. For a similar cargo carrying capacity, the motorship, other things being equal, can be designed with a higher speed than a steamer. With the steamer an increase in speed of a few knots may conceivably require an increase in overall dimensions owing to the increased size of machinery and bunker space. The motorship, however, requires a smaller space both for machinery and fuel. Furthermore, a 14½ knot motorship burns only 23 to 25 tons of fuel oil per day as against the 75 tons of the steamer.

MALAYAN PRINCE and her sisterships ASIATIC PRINCE, JAVANESE PRINCE, JAPANESE PRINCE and CHINESE PRINCE are vessels of shelter deck type with a short forecastle and a midship house which has accommodation for the crew, at shelter deck level, and for the engineer and navigating officers and eight passengers on the next deck above. Above this again is a boat deck. There are two tiers of 'tween decks. All deck auxiliary machinery is electrically driven, and thirteen 5-ton and four 3-ton winches take care of the cargo. In addition, there is one 30-ton and one 40-ton derrick for handling heavy lifts. A stack of normal size takes the main engine exhaust and the profile is



Malayan Prince, first of five large Prince Line motor freighters, recently returned to New York after her maiden round-the-world voyage

completed with a straight stem and a cruiser stern.

The vessels are powered by 2 sets of 8-cylinder A. E. G.-B. & W. engines with cylinder diameter 89½ in. by 47 in. stroke, developing collectively 5600 b.h.p. at 125 r.p.m. These engines are designed to give the ship when loaded to full capacity a speed of 14½ knots. An exhaust gas heated boiler, with a working pressure of 50 lb. per sq. in. is arranged on the port engine exhaust system. There are three auxiliary generating sets, each driven by a 3-cylinder 150 b.h.p. A. E. G.-B. & W. trunk piston engine, supplying current for the deck and engine room auxiliary machinery, and these operate in port to supply the necessary current for the deck auxiliaries.

Malayan Prince Maiden Voyage Schedule

PORT	DATE	DAYS FROM N.Y.
New York A.	March 15	—
New York S.	March 25	
Hampton Rds. A.	March 26	1
Hampton Rds. S.	March 27	
Colon A.	April 2	8
Panama S.	April 2	
Los Angeles A.	April 11	17
Los Angeles S.	April 12	
Yokohama A.	April 29	35
Yokohama S.	May 1	
Kobe A.	May 3	39
Kobe S.	May 4	
Shanghai A.	May 7	43
Shanghai S.	May 10	
Hong Kong A.	May 13	49
Hong Kong S.	May 13	
Manila A.	May 15	51
Manila S.	May 18	
Ilo ilo A.	May 19	55
Ilo ilo S.	May 21	
Cebu A.	May 22	58
Cebu S.	May 23	
Sourabaya A.	May 27	63
Sourabaya S.	May 28	
Samarang A. & S.	May 29	65
Batavia A.	May 30	66
Batavia S.	June 2	
Singapore A. & S.	June 11	77
Penang A.	June 15	82
Penang S.	June 16	
Suez A. & S.	July 1	98
Port Said A. & S.	July 2	99
Boston A.	July 17	115
New York A.	July 20	119

Prince Line plans to maintain its five new motorships on a round the world service from New York back to Boston and New York via Newport News, Panama Canal, Los Angeles, Yokohama, Kobe, Shanghai, Manila, Sourabaya, Samarang, Batavia, Singapore, Penang and Suez. General cargo, comprising such commodities as machinery, flour in bags, lubricating oil, cotton, tobacco and cigarettes is carried outwards from New York and Newport News and unloaded at all ports up to Manila, which marks really the end of the outward portion of the voyage. The return cargo, picked up partly at the unloading ports and partly at the ports of call in the Dutch East Indies and in the Malay Peninsula comprises tea, sugar, rubber, Chinese groceries—a generic term for foodstuffs imported for Chinese resident in the United States comprising anything from a 1000 year old egg to edible bird's nests—pepper, spices, rattans, bamboos and rubber.

MALAYAN PRINCE carried from Manila to

New York 860 tons of coconut oil in her deep tank. This liquid cargo is not handled by the ship pumps in any way but is loaded and pumped out by shore people. It must be at a temperature of about 110 deg. Fahr. before it can be unloaded.

The forward and aft peak tanks of these ships are fitted with special pumps and pipe lines to enable them to load and discharge liquid rubber or latex, as it is called.

It is evident, although it is as yet early days, that these new motorships are making large inroads upon the Far Eastern trade. The effect of their presence must be felt even by rival motorships because the new ships are offering to shippers something which is definitely faster than anything at present on the route. This is a powerful weapon in the hands of the owners since they can, and do, advertise their service as "an improved service—which will be further improved upon," a conservative schedule having been purposely adopted for the start. As far as rival steamers are concerned, the owners of the new ships have the pull of offering to shippers something which is the latest and most modern in every way—a psychological pull of some value. Following is a table giving the ports of call and scheduled times for the new Prince liners. This takes care of the outward journey as far as Manila and is expected to be improved on as the new ships settle down into routine working conditions.

Prince Motorliner Schedule

PORT	DAYS TAKEN
Yokohama	35
Kobe	39
Shanghai	43
Hong Kong	49
Manila	51

Dates of arrival and departure of MALAYAN PRINCE on her maiden voyage are also shown. It will be noted from this that she made the Atlantic and Mediterranean "leg" of the voyage in very reasonable time. Very little, if any, falling off in speed was noticed which could be attributed to foul bottom conditions, and such falling off might quite well be expected after a lengthy round the world voyage. This is to be attributed to the higher speed at which this particular ship operates. It is one of the advantages of the high speed freight motorships compared with a slower steamer or even a slower motorship.

Fueling for the round trip New York to New York is carried out four times. Sufficient is taken on at New York to take the ship to Los Angeles, a second quantity loaded at Los Angeles lasts until Singapore is reached, while the amount taken on at Singapore carries over as far as either Port Said or Gibraltar, a final load being taken at one of these two ports.

Among other lines operating in round the world services running out to Far Eastern ports and home via the Mediterranean may be mentioned the Kawasaki-Roosevelt Line, agents for whom are the Kerr S. S. Co., Inc.; the Dollar Line, and the Barber Steamship Lines, Inc. The Bank Line runs out to Far Eastern ports with 11 knot motor freighters, but these ships generally return to New York via the Pacific. Each of these has a slightly different itinerary and schedule. Kawasaki-Roosevelt Line maintains a joint motorship-steamer ser-

vice, using the 6 motorships of the Silver Line Ltd. in conjunction with steamers of the Japanese "K" Line. Silver Line fleet comprises 3 Doxford-engined and built ships of about 8000 tons deadweight capacity and 10 knots speed, 2 Swan Hunter-engined and built ships of 8600 tons deadweight capacity and 11 knots speed, and 1 J. L. Thompson-built and Doxford-engined ship of 7900 tons deadweight capacity and 11 knots speed. Silver Line has now under construction 6 motorships of 9000 tons deadweight capacity and 14½ knots speed, which are expected to be ready for service by the end of the year. Prince Line will then have to face the competition of new ships, just as fast and of practically the same cargo capacity, as its new ships. Dollar Line round-the-world fleet comprises four 535 ft. Shipping Board liners of "President" type. These are passenger and cargo steamers of about 13,000 tons deadweight capacity and 15 knots speed, having accommodation for over 400 passengers. There is probably very little difference in the respective cargo carrying capacities since the fuel capacity of the steamer in proportion must be considerably larger than that of the motorship. The fuel consumption of a steamer, too, is unquestionably higher than that of a motorship. In fact, there is no doubt that the large steamers will have to be run very economically and their operation carefully watched in order to compete successfully with the new motorships, where cargo is concerned.

Following is a table showing the difference in the schedule followed by the three principal round the world routes. It will be seen that the Dollar Line omits the Dutch East Indies calls.

Round-the-World Service Itineraries

KAWASAKI-ROOSEVELT		
PRINCE LINE	LINE	DOLLAR LINE
New York	New York	New York
Newport News	Norfolk	Havana
	Savannah	
Los Angeles	Los Angeles	Los Angeles
		San Francisco
Yokohama	Yokohama	
		Honolulu
Kobe	Kobe	Kobe
	Darien	
	Taku Bar	
Shanghai	Shanghai	Shanghai
Hong Kong		Hong Kong
Manila	Manila	Manila
	Macassar	
*Samarang	Samarang	
*Sourabaya	Sourabaya	
*Batavia	Batavia	
Singapore	Singapore	Singapore
	Medan	
Penang		Penang
	Colombo	Colombo
Suez		Suez
Gibraltar		
		Port Said
		Alexandria
		Naples
		Genoa
		Marseilles
Boston		Boston
New York	New York	New York

* As cargo offers.

McNab-Ford torsionmeters are installed on the mortorliner ASTURIAS and are to be fitted on her sister ship ALCANTARA now completing. This type of instrument is also fitted to the Ms. CANARVON CASTLE.

A FAIRBANKS-MORSE engine of 125 hp. is being fitted in a 65 ft. towboat constructing at the Supple & Martin Shipyard, Seattle.

CELLINA, 2600 i.hp. motorship owned by the Navigazione Libera Triestina and operating on the service subsidized by the Italian government between Naples and Vancouver via Palermo, Teneriffe, Antilles, Panama, San Francisco and Seattle, recently visited San Francisco on her maiden outward voyage. Three other motorships are to be employed in the same service. CELLINA has 14,000 cu. ft. refrigerated space suitable for carrying fruit and meat from California. She carries marble, olive oil and art goods on her outward voyage.

A draft bill has been approved by the German-Ministry of Finance in regard to a plan for financial assistance to inland shipping.

Storsten is the name of a new 5150 ton gross motor freighter fitted with a North British double-acting 2-cycle Diesel. This vessel is the third ship so fitted and was built by Barclay, Curle & Co., Glasgow, for the Tonsberg Rederi, Tonsberg, Norway. Her maiden voyage was from the Clyde to Bermuda.

Roosevelt Advocates Motorships

Economies in fuel and crews in addition to greater cargo carrying space are some of the advantages accruing from the motorship visualised by Kermit Roosevelt, president of the Roosevelt Steamship Company, now operating vessels of the American-India and Atlantic-Australian Lines. Ships at present on this run are steamers, but, states Mr. Roosevelt, "the greatest need on these long voyages is for motorships to replace coal burners now in use. We hope to get some of the vessels the Shipping Board is converting to Diesel drive. These would enable us to effect economies in fuel and crews, in addition to allowing more cargo space."

Another S. F. Bay Tanker

Union Oil Co. of California is now asking bids on a twin-screw harbor tanker, with direct-reversible Diesel drive and hull characteristics as follow:

S. F. Bay Tanker Characteristics

Length overall.....	216 ft. 0 in.
Length, b.p.	210 ft. 0 in.
Beam, molded.....	42 ft. 0 in.
Depth, molded	16 ft. 0 in.
Cargo capacity	12,000 bbl.

The vessel will be of the single deck type with transverse framing of hull. The two main engines are to be of direct-reversible marine Diesel type of 350 b.hp. each, with mean effective pressure not exceeding 78 lb. per sq. in.

Two Diesels are to be installed for auxiliary purposes, one of 250 b.hp. with cylinders of the same bore and stroke as the main engine, is to have an extension shaft at each end for driving two 1500 bbl. per hour capacity (150 lb. pressure) Kinney cargo pumps at approximately 260 r.p.m. through flexible couplings and clutches. The other Diesel is to be of 30 b.hp. at 450 r.p.m. and will drive an 18 kw. 115 volt generator.

Motorship

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Readers are invited by the Editor to submit articles, photographs or drawings relating to motorships, marine oil-engines or auxiliaries. Contributions used in the magazine are paid for on the 15th of the title month of issue, and other contributions are returned as promptly as possible.

Union Oil Co. of San Francisco is to construct a motor tanker of about 210 ft. in length for service in Los Angeles harbor.

Motortug HUSTLER which the Bethlehem Shipbuilding Corp. sold recently to the O.J.C. Towing & Transport Co. of Staten Island recently completed a successful maiden voyage from New York to Buffalo and back via the State Barge Canal. She is fitted with one 320 hp. engine of the Bethlehem type.

A 90 ft. Diesel yacht is to be constructed by M. M. Davis & Sons, Solomons, Md., for Robert C. Roebling of Washington, D. C. This motoryacht will be of the twin screw type and will be fitted with a Gyro compass. She is the second vessel constructed for Mr. Roebling in the past three years.

San Francisco office of the Furness Line has announced that four 10,000 ton, 13 knot refrigerator motorships are now being constructed in Scotland for Pacific-United Kingdom service. Upon their completion this will make a total of twelve ships engaged in this service.

OHIO, 513 ton motoryacht owned by the late E. W. Scripps has been purchased by Lord Beaverbrook, publisher of the London *Daily Express*, and is to be named MIRAMICHU. The yacht is powered by two Winton Diesels developing 700 hp. collectively. She has registered dimensions 160.5 ft. by 26 ft. by 14.6 ft. Her late owner died on board his yacht off the Coast of Africa while on his second voyage around the world. The vessel has cruised a distance of about 96,823 miles since her commissioning.

A Bethlehem Diesel of 100 hp. is fitted in a fishing boat now completing at the Jakobson & Petersen Shipyard, Brooklyn.

Southern Pacific Ferries

Twenty-three bids from seventeen different United States Diesel engine manufacturers were presented to the Southern Pacific Company for consideration in the proposed program calling for the construction of five new Diesel-electric automobile ferryboats for San Francisco Bay service.

The great variety of engines represented, has called for careful analysis on the part of the Southern Pacific engineers, who are desirous of building high grade, modern, and efficient ferries for the \$3,000,000 appropriated for this purpose.

The engine builder has not yet been selected. The 400 b.hp. size of Diesel engine is within the scope of builders of large and of small sizes and therefore the keenest interest has been displayed throughout the country as to the outcome of these bids.

Interesting Bids

Bids received by a concern recently calling for tenders for 6-cylinder, 400 b.hp. Diesels for driving generators, are of interest as indicating the trend of present day practice. A few pertinent facts are summarized below:

Analysis of Engine Bids

2-cycle engines.....	23½ per cent of total.
4-cycle engines.....	76½ per cent of total.
Air-injection engines....	35 per cent of total.
Airless-injection engines..	65 per cent of total.
Average r.p.m.....	275
Average piston speed.....	844 ft. per min.
Average m.e.p.....	71½ lb. per sq. in.
Average factory price per b.hp.....	\$60.00

The ratio of airless-injection to air injection engines is almost two to one. The 4-cycle prices were as low as the 2-cycle prices.

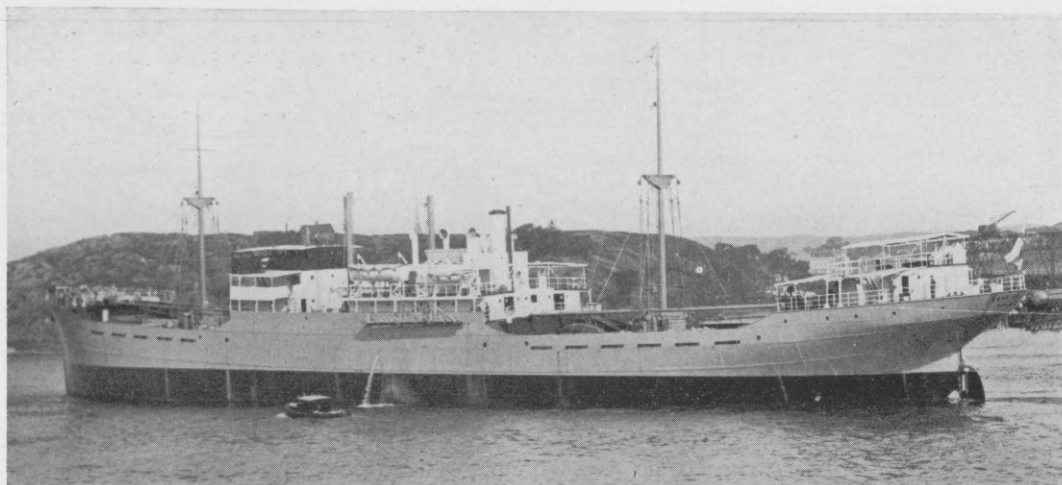
Undoubtedly, purchasing agents will smile at the downward trend in cost of Diesel engines. The tendency in design seems to be to increase the revolutions per minute without materially increasing piston speed, thereby preserving good rates of gas expansion and avoiding troublesome exhaust gas velocities or high rubbing velocities. Evidently manufacturers believe in sticking to conservative ratings in mean effective pressures.

7 New San Francisco Ferries

California State Railroad Commission has granted the Golden Gate Ferry Co., of San Francisco, permission to operate automobile ferries between San Francisco and Berkeley. Rapidly growing traffic between these cities, has prompted a popular demand for this service and the operation of the new route will probably require four additional ferries. The asking of bids, however, has been delayed pending the outcome of the request made by the Golden Gate Ferry Co., to operate automobile ferries to Alameda from San Francisco. This latter service will require at least two automobile ferries, making a possible total of seven new ships to be built inclusive of one new ferry for the San Francisco-Sausalito run.

Danish North Sea Motorships

Denmark continues to pioneer in placing motorships on passenger routes in the North Sea and adjacent waters, United Steamship Co. of Copenhagen having just ordered a motorship from the Elsinore Shipyard for its Copenhagen-Leith-Iceland route. A steamer named ISLAND is at present on this route and while the dimensions of the new motorship will be the same as those of the steamer, the fact that the new boat is to be Diesel propelled will give her greater cargo space and better passenger accommodation. She is to have a length of 251.2 ft. with a beam of 38 ft. and a speed of about 12½ knots. United Steamship Co. has now placed in service a second motorship to run alongside PARKESTON in its Harwich, England-Esbjerg, Denmark, passenger and mail route. This new ship named JYLLAND is 321 ft. in length and 44 ft. beam. Her gross tonnage is 2761 tons. The speed loaded on trial trip was 15¾ knots, and two 6-cylinder B.&W. engines developing collectively 3800 i. hp. at 180 r.p.m. A daily connection between the two terminal points on this route is now maintained by two steamers and two motorships.



Swedish ore fleet now has a motor freighter of "three island" type—Erik Frisell

"Three Island" Ore Ship

Last of a fleet of eighteen ore ships, sixteen of which are motorships, constructed by the Gotaverken Co., for the Grangesburg-Oxelosund Co., ERIK FRISELL, 7500 tons ship has now been completed. Attention was drawn to her launching in July MOTORSHIP. The vessel was delivered

to her owners on July 15.

She is of interest because she and her sister ship MURJEK are the only two motorships of the large fleet owned by the Grangesburg Co. of three island type.

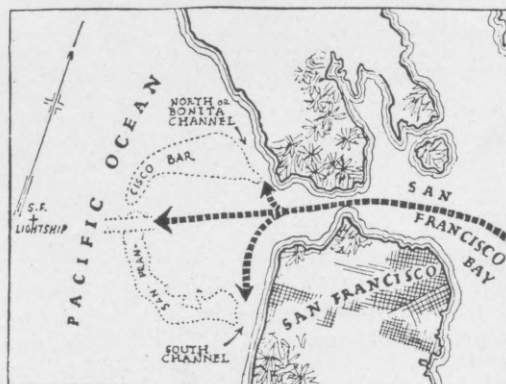
ERIK FRISELL has a length b.p. of 390 ft., beam molded of 52 ft. 6 in. and a depth to main deck of 30 ft.

Electric Dredge A. Mackenzie

ORDERED from the east coast by the U. S. Engineer Department to make some harbor improvements in San Diego while en route to San Francisco, her home port, the sea-going Diesel-electric dredge A. MACKENZIE arrived in San Francisco on July 8.

The dredge was drydocked in Oakland for the purpose of painting bottom and drawing tail shafts before proceeding to Grays Harbor where six weeks' work was scheduled before she returned to San Francisco.

On returning to San Francisco, A. MACKENZIE will work with the steam dredge CULEBRA on a number of harbor improvements. The work accomplished by these two



San Francisco Bar

steam dredge when fuel oil is around \$1.60 per barrel. San Francisco bar will be a good proving ground and accurate comparisons can be made under similar operating conditions.

CULEBRA has been working over the San Francisco bar for the past two years and has only been forced back into the harbor twice during the past year. This is a remarkable record in view of the heavy seas and rough weather often encountered there. A comparison of the principal characteristics of the two dredges is shown in the table.

Steam and Electric Dredge Compared

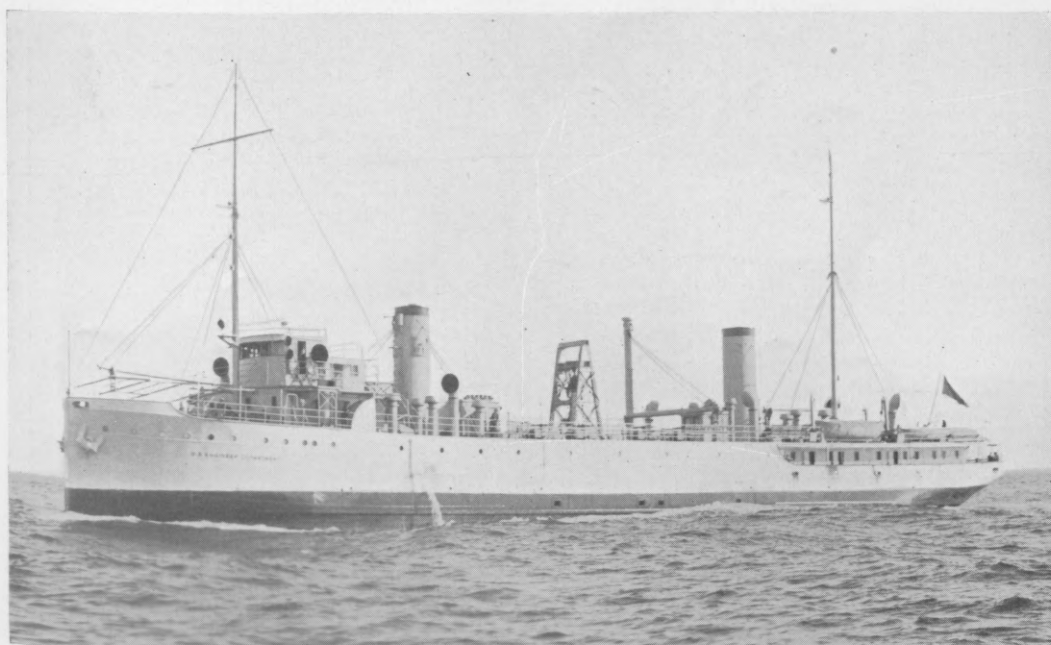
CHARACTERISTICS	CULEBRA	A. MACKENZIE
Length	288 ft.	268 ft.
Breadth, molded ..	47 ft.	46 ft.
Depth	25 ft.	22½ ft.
Hopper capac.	2258 cu. yds.	1450 cu. yds.
Speed	12 knots	11½ knots
Power	3000 hp. steam	3000 hp. Diesel
Propulsion	Comp. steam single screw	Electric motors twin screw
Dredging capac. (sand & shells) per month.	300,000 cu. yds.	300,000 cu. yds.

Second French Motorliner

The second French motorliner will shortly be laid down at the yard of the Société Provencale de Constructions Navales. This vessel is intended for service between Marseilles and Australia.

The contract for construction has been placed by the Messageries Maritimes after deliberation for some months as to the relative merits of steam and Diesel machinery. Decision has finally been made to power the vessel with two 8-cylinder Sulzer units developing a total of 6000 b.hp. There will also be four auxiliary engines of 320 b.hp. each direct coupled to a generator.

THEOPHILE GAUTIER, first French motorliner which is being built for the same owners, was launched nearly complete from the Dunkirk yards of the Ateliers et Chantiers de France, on June 26.



Electric dredge A. Mackenzie is now working on San Francisco Bar

dredges will be watched with great interest, particularly in view of the fact that

at the present time it is believed that A. MACKENZIE is cheaper to operate than a



Towboat Marion Adele has pilot house control and direct Diesel drive

55 Ft. Diesel Towboat

MARION ADELE, 55 ft. Diesel towboat, has been completed recently by the Rancocas Construction Co. at Delanco, N. J., for the Meteor Transport & Trading Co., Miami Beach, Fla. She was designed by J. Murray Watts, Naval Architect, Phila. The boat is powered by a 150 hp. 6-cylinder Standard full Diesel engine which turns a 4-bladed wheel 50 in. diameter by 36 in. pitch at 400 r.p.m. and gives the vessel a speed of 14 m.p.h. light. MARION ADELE has a length on waterline of 52 ft., beam of 15 ft., and draft of 5 ft. 6 in. Pilot house control has been fitted so that the vessel may be handled by one man. Electric bilge pump, air compressor and general service pump are installed.

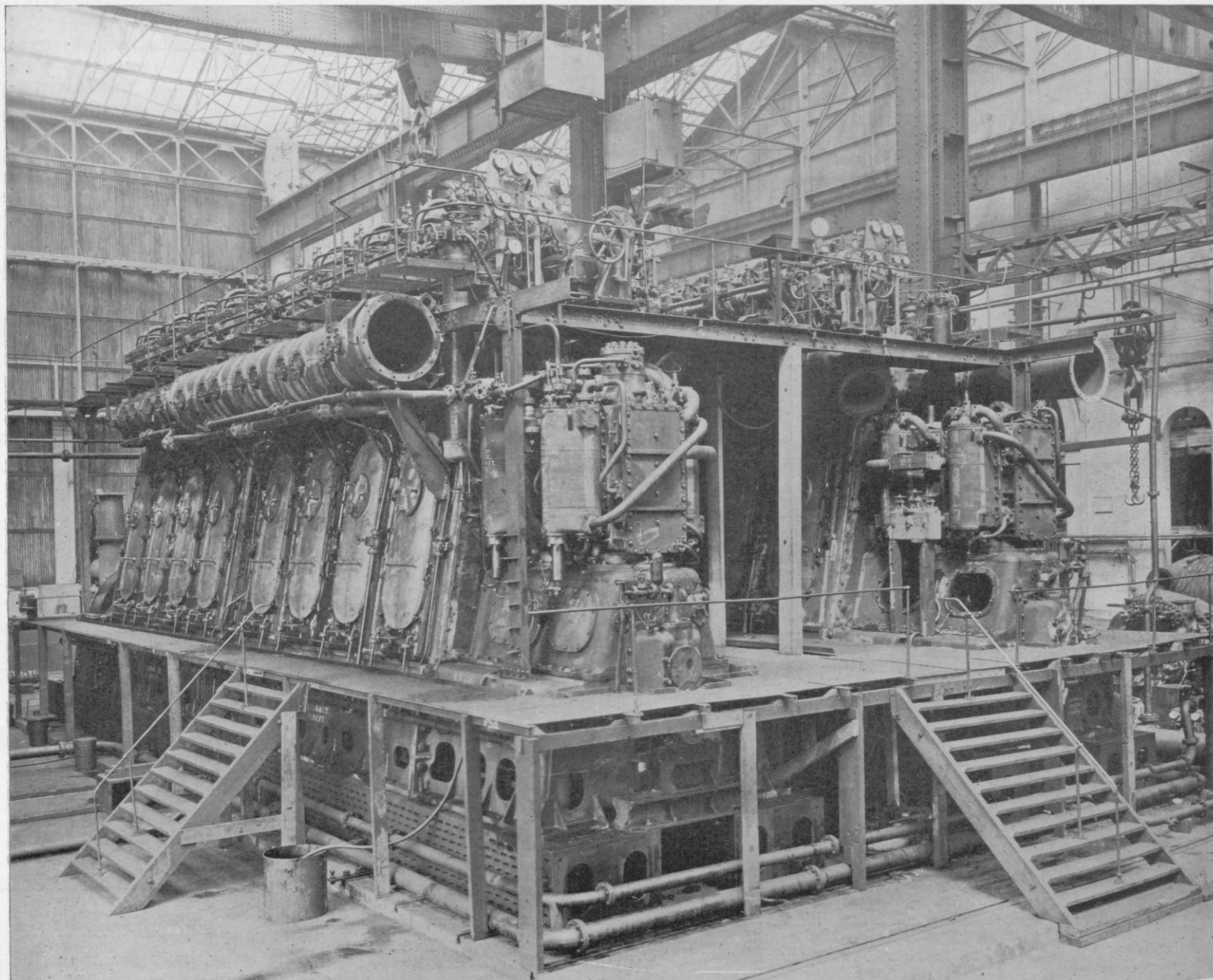
Two New Motorliners

SHROPSHIRE, a twin-screw passenger and cargo motorliner 502 ft. long, 60 ft. breadth molded and 36 ft. 3 in. depth molded to upper deck, specially designed for the Liverpool-Rangoon trade of the Bibby Line, calling at various ports en route is representative of a number of high class passenger motorliners constructing in European shipyards. She is powered by twin sets of 8-cylinder, Fairfield-Sulzer Diesels, having cylinder dimensions, 28 in. diameter by 39 in. stroke rated at 7700 collective b.h.p. at 110 r.p.m. and illustrated below.

Two 3-stage compressors for injection air are driven by cranks at the forward end of each engine, and scavenge air is supplied by two electrically driven turbo-blowers, each blower being capable of supplying the air required for two engines. All auxiliary machinery is electrically driven, power being obtained from three 275 kw. Diesel-driven generator sets. A small Cochran boiler takes care of the ships' heating and galleys.

SHROPSHIRE is expected to be completed within the next month or so. CHESHIRE, a sister vessel, is also under construction at the Fairfield S. B. Co., Glasgow.

BARBARA, 3000 ton rotor ship, and second rotor ship to be constructed has passed successfully through a series of trial trips in the North Sea. Besides having three large rotors she is fitted with Diesels for auxiliary use. Her performance was good and she maintained a speed of 10 knots with rotors turning at 86 r.p.m. BARBARA has been constructed in Hamburg and is to be chartered by the Robert Sloman Co. for the fruit trade to Hamburg.



Two passenger and mail motorliners building for Bibby Lines' Liverpool-India trade are each powered with twin single-acting 2-cycle Diesels

Sueja III New Pacific Coast Flagship

Motoryacht Has 360 Hp. Airless Injection Engines and Large Range of Electric Auxiliary Equipment

SUEJA III, 117 ft. motoryacht recently put into commission by Capt. James Griffiths, Admiral of the Pacific Coast Yachting Association and ex-Commodore of the Seattle Yacht Club, is one of several large Diesel-driven cruisers launched on the Pacific Coast during the past twelve months. She has a length of 117 ft. 0 in., by 19 ft. 0 in. beam, by 8 ft. 6 in. draft and is powered by Diesels of 360 collective horsepower.

Captain Griffiths is one of the best known yachtsmen on the western seaboard and for many years he has been one of its most active motorboat men and has owned a number of cruising yachts. In his new boat Captain Griffiths desired to have a sturdy vessel capable of making long trips into northern and southern waters and SUEJA III in the several short trips she has taken since her launching, promises to meet those requirements in every particular.

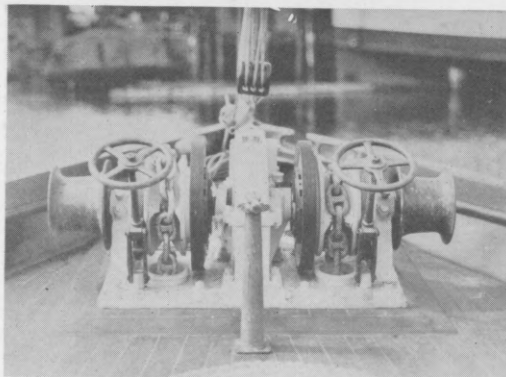
The yacht was designed by L. E. Geary of Seattle. The frames and joiner work were prepared in knock-down form in China after which they were shipped by steamer to Seattle where they were assembled, and the yacht completed, at the Winslow Marine Railway, Captain Griffiths' own shipyard on Bainbridge Island.

SUEJA III is of very strong construction throughout, the hull having heavier scantlings than those of a Pacific Coast workboat, and in addition all timbers are selected Oriental hardwoods. Keel, keelsons, frames and all longitudinal members are of yacal as is the hull planking below the waterline. The topsides planking, decks and all joiner wood are of teak.

The arrangement of the accommodations

on SUEJA III have been worked out so as to give the greatest degree of roominess and comfort to the owner and his guests. The upper deck is given over to the life boats and to the pilot house and bridge. The main deck has a dining saloon at the forward end and a deck saloon at the after end.

Immediately aft of the dining saloon is a large pantry containing an electric warming oven, sink and lockers for linen and



Electric winch

silverware. This pantry communicates with the galley directly below by means of an athwartship stairs. Between the pantry and the after deck saloon is a state-room for the captain, a companionway giving access to the engine room and a vestibule to the after cabin.

Below decks, forward of the engine room, are the forecabin with crew's toilet forward, rooms for the engineer and mate, crew's mess and galley. Aft of the engine

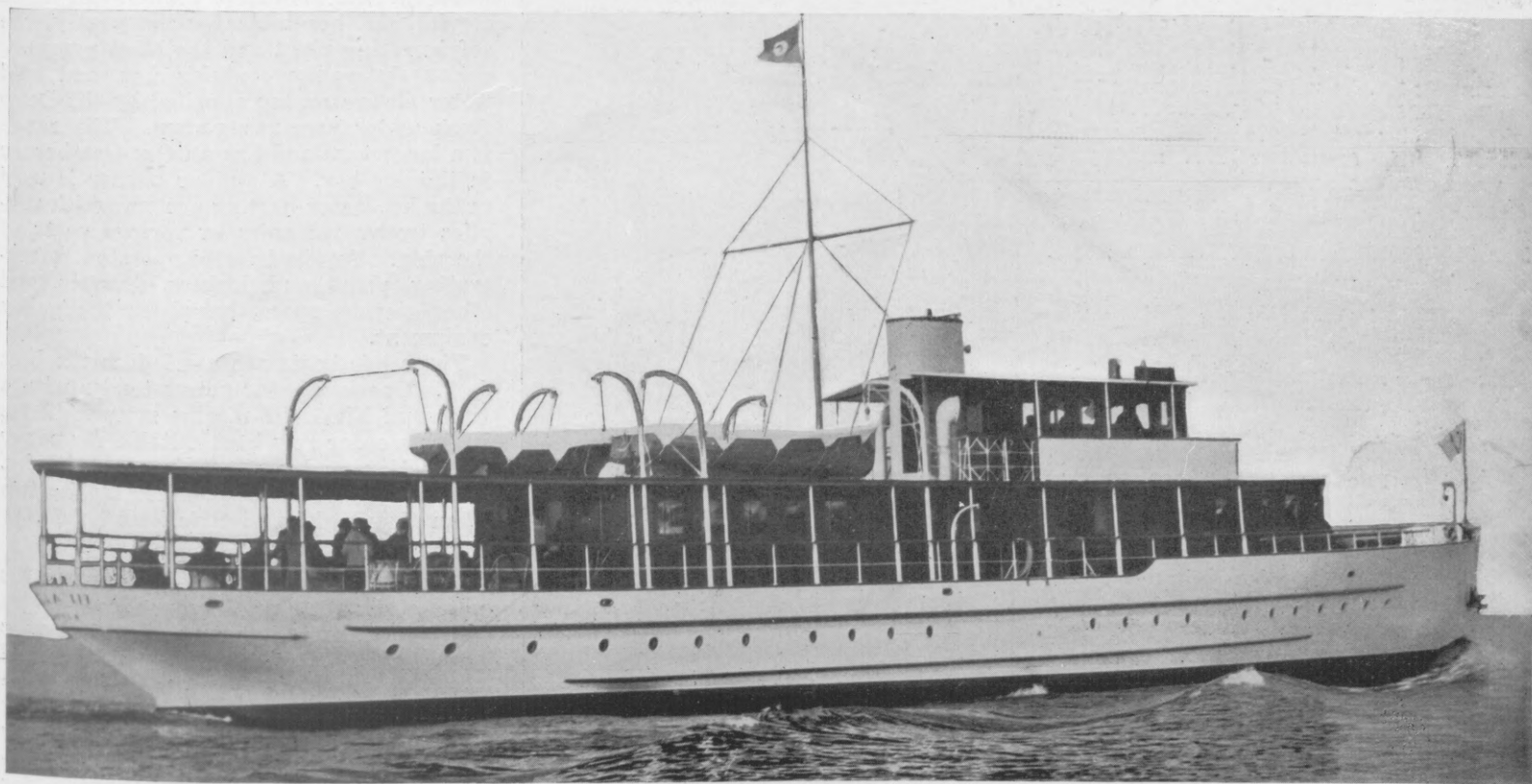
room is the owner's room, extending the full width of the ship and opening on a central companionway along which are four single staterooms and a ship's bath and toilet. The large double stateroom aft has a private toilet adjoining and the owner's stateroom has a private bath and toilet.

The owner's stateroom, though just aft of the engine room, is thoroughly insulated from all noise by a soundproof, watertight bulkhead. In addition, the main fuel tanks, located against the after bulkhead of the engine room, serve to deaden any sound.

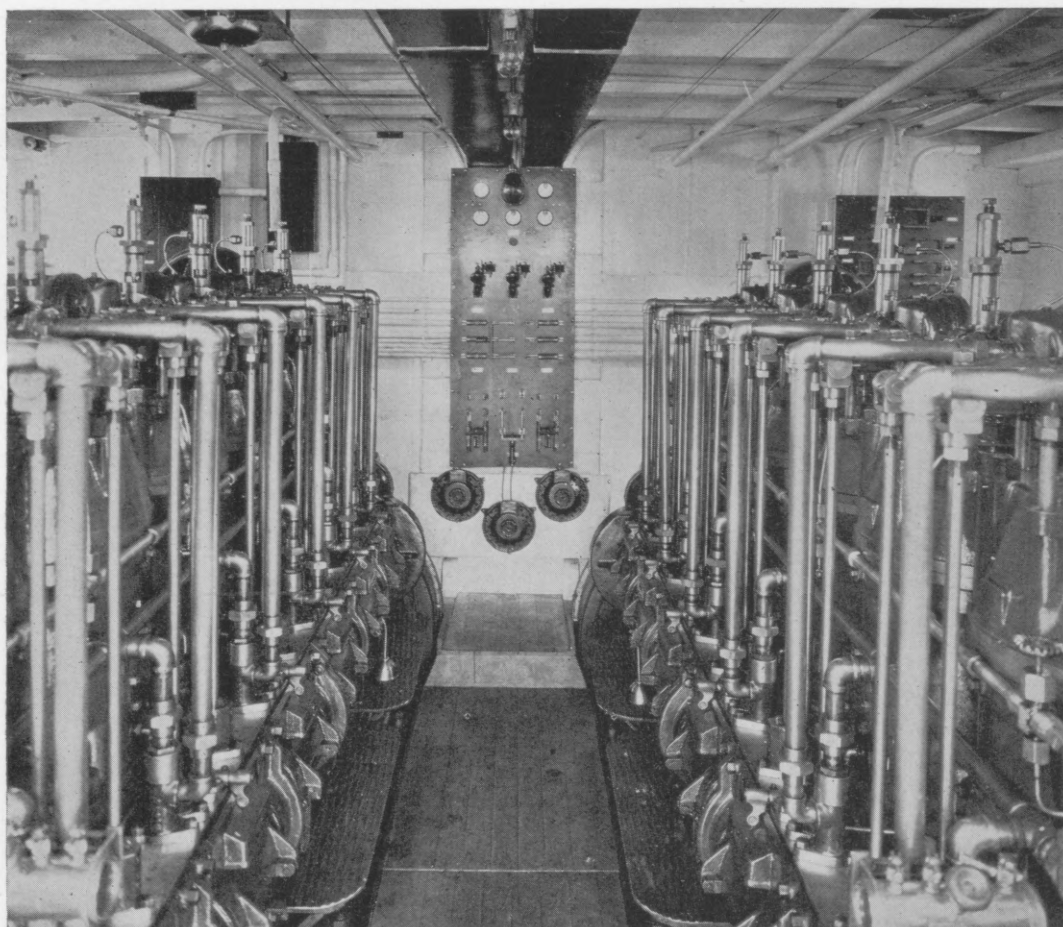
The two main propelling units, each with a belt-driven generator at its forward end are in the center of the engine room. On the port side is a large work bench and shelves for the storage batteries. On the starboard side aft is a Bolinder auxiliary engine, Delco pressure water system, and a tool rack. On the forward bulkhead are the main power distribution switchboards. The arrangement of the engine room was worked out by F. A. Andron, who is in charge of the yacht.

SUEJA III is completely maneuvered from the pilot house. The special air controls for the clutch as well as the fuel controls for the main engines are brought to the helmsman's hand. Steering is done directly by means of an Allan Cunningham bronze roller-sprocket type of steering gear. Other navigating equipment includes a Ritchie compass and barometer furnished by the Northwest Instrument Company, an Allan Cunningham air whistle and a Sperry searchlight of 800,000 candle-power.

The main engines are twin 6-cylinder Washington Estep full Diesels of airless-injection type. Cylinders are 9½ in. bore



Sueja III has been specially designed to make extended cruises and her hull is strongly constructed of Oriental hardwood

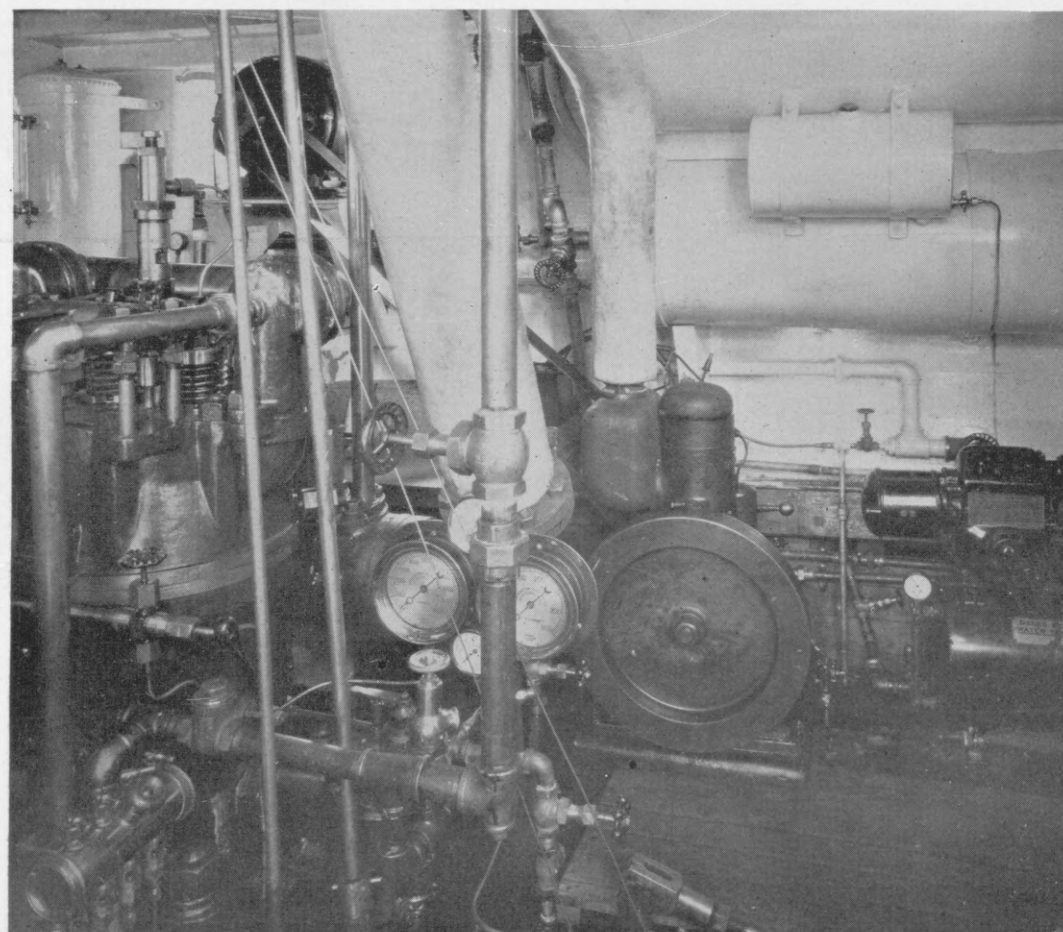


Main engines in a compact working space are of airless injection type with pilot house control

by 12½ in. stroke and the engines are conservatively rated at 180 hp. each. On her trial trip the yacht, which was designed for a speed of 12 knots, actually made 12½ knots with the engines turning over at 10 r.p.m. less than the maximum called for.

The engines are of the open main frame

construction with removable cylinder liners. The pistons can be taken out through doors in the frame side without dismantling the cylinder heads and valve gear. Extra long connecting rods are used with force feed oiling system throughout. Exhaust is carried out to the stack through Maxim silencers.



Engine room is neatly arranged with necessary auxiliaries within easy reach

The yacht is also equipped with a new departure in air clutch controls which is a patented feature on the engines. The entire control for each engine is worked from one stand. A lever controls air admitted to a cylinder which operates the clutch in such a way that the latter may be slipped either in the forward or reverse position, or engaged quickly either ahead or astern. An automatic release feature releases the air at either end of the cylinder so as to eliminate any riding on the shifter collar. The valve mechanism is balanced, making the operation very easy and positive. The air pressure necessary to operate the clutch is 80 pounds and this air is delivered to the cylinder through a reducing valve. This makes the most economical installation, due to the fact that there is not a great amount of high pressure air wasted.

On her first trip, from the shipyard at Winslow, Wash., across the Sound and up through the Government Locks to the Seattle Yacht Club where she is berthed, SUEJA III was handled entirely by pilot house control.

Current for lights and for the various electrical machinery on board is generated by two 3½ kw. Fairbanks-Morse generators belt-connected to the main engines, and when the main units are not running, by one 3½ kw. generator of the same make driven by a 6-7 hp. high speed Bolinder oil engine.

These generators charge a set of Exide storage batteries from which current is drawn at either 32 or 64 volts, the boat being wired in such a way that the system can be used at either of these voltages. The higher voltage is required for operation of the winch motor. The wiring and the switchboard were installed by the Folger Electric & Machinery Corporation of Seattle.

Current is used for the operation of a lathe, a grindstone, the two Allan Cunningham boat hoists and the Allan Cunningham anchor windlass, the pumps for the Delco water system, the pumps for the salt water service, the hot table for the pantry, the refrigerating plant and the bilge pumps.

SUEJA's galley contains hot and cold water always on tap supplied by the Delco fresh water pressure system. The range is a large type and has an Oxo-Gas burner in the fire box. A similar burner is used in the hot water heating system which supplies twelve radiators in various parts of the ship. An electrically operated refrigerating plant and lockers, drawers, and other storage space, completes the galley equipment.

Three life boats are carried on the boat deck. One is a cedar power tender with a Universal Flexifour marine motor. There is also a cedar row boat suitable for power installation and a 12-ft. rowing dinghy. All of these boats are handled by the two Allan Cunningham electric boat hoists.

Preference for motorships is shown in the discriminatory time-charter rates quoted for motorships and steamers in the Pacific lumber trade, states *Shipbuilding and Shipping Record*. Vessels have been wanted for nine and twelve months trading and rates of \$1.35 have been quoted for motorships of from 7000 to 8000 tons dead-weight with rates of \$1.00 to \$1.05 for steamers burning coal or oil. A rate of 80 cents is known to have been accepted for a large coal burner taken for five months.

European "Bay" Type Tanker

COMPARABLE with modern Diesel-driven tankers now in service and building for work on San Francisco Bay, MARGARETA constructed by Nüscke & Co., Stettin for the Nobel-Standard Company of Helsingfors is powered with a 4-cylinder 2-cycle Hamburg-Mannheim Diesel of direct reversible type capable of developing 340 b.hp. at 190 r.p.m. It was a condition of design with this ship that she should be able to carry 550 tons of gasoline on a maximum draft of 9 ft. Careful investigation was necessary to ensure the fulfilling of this condition and to ensure further that the machinery should be capable of giving the loaded vessel a speed of 9 knots in fine weather. Experiments were carried out in the Berlin tank to determine the best hull form. On a draft of 9 ft. the block, midship section, and waterplane area coefficients are respectively 0.77, 0.97 and 0.888.

MARGARETA is built in the transverse system of framing with a raised poop and forecastle. Machinery is aft and pump room amidships, four double oil tanks, divided by the usual fore and aft center-line bulkhead, being placed between the latter and the former, and four between

the latter and the store in the forward hold. Officers are berthed aft and crew in the forecabin.

Steam drives the cargo oil pumps and deck machinery and heats the tanks, being supplied by a small oil-fired boiler. The windlass, however, can also be driven by compressed air. A 15 hp. Diesel-driven generator supplies current for lighting and auxiliary purposes, but provision is made for the dynamo to be belt-driven from the main engine shaft when the ship is at sea.

On the trial trip, a shoal water speed of 8.6 knots was made, but an average service speed of 9.5 knots has been maintained. This vessel represents a European interpretation of a design for which there is a considerable demand in domestic waters. She is therefore worth noting.

A very full description was published recently in our German contemporary *Werft Reederei Hafen*, from which the general arrangement plan is reproduced with acknowledgment.

Following are the vessel's main characteristics compared with those of a recent San Francisco Bay tanker now actively employed in gasoline transport.

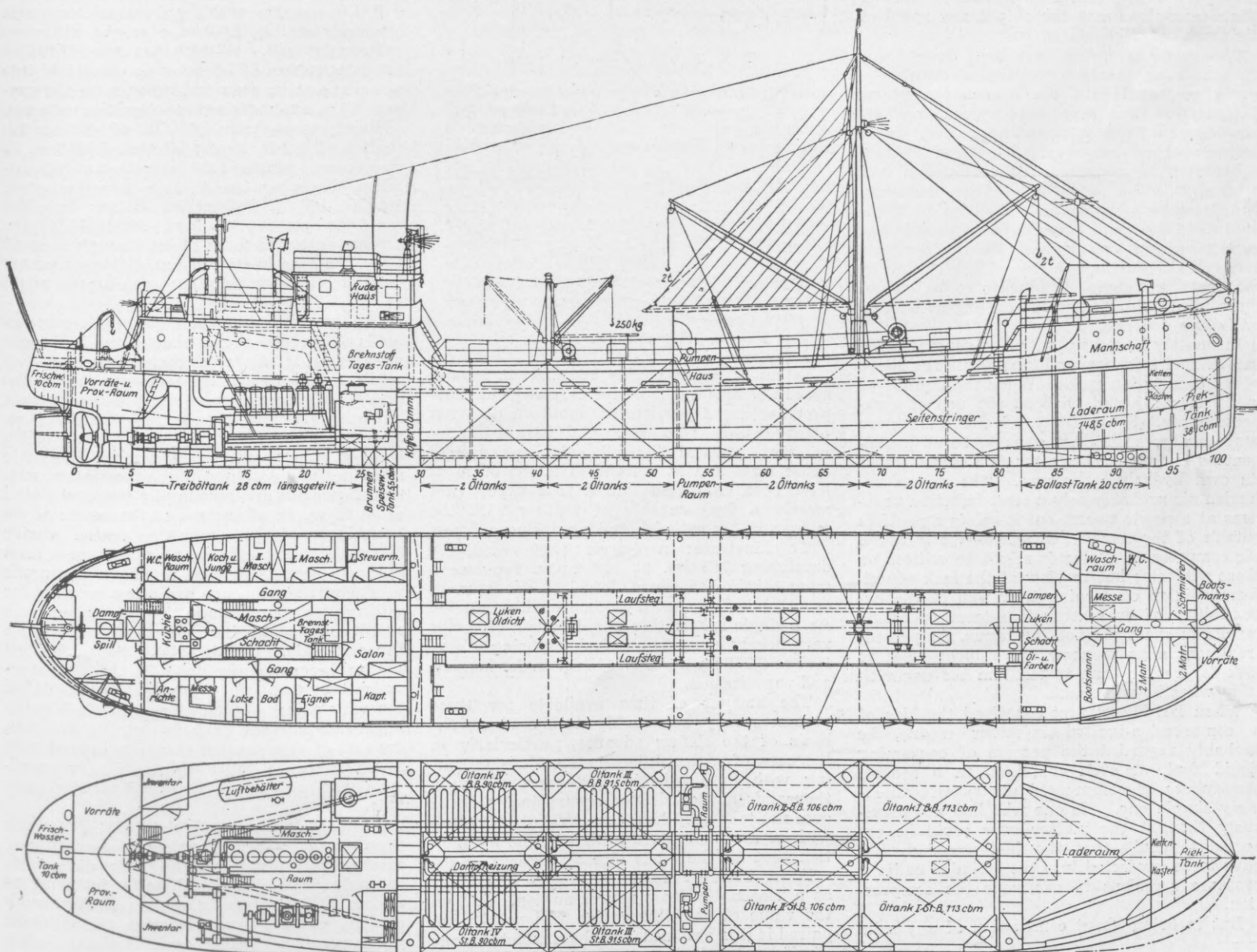
Bay Tanker Characteristics

	MARGARETA	SAN FRAN. BAY TANKER
Length o. a.	188.5 ft.	166 ft.
Beam, molded	29.5 ft.	38 ft.
Depth, molded	11.5 ft.	9.6 ft.
Capacity	550 tons	3500 bbl.
Power	340 b.hp.	220 b.hp.

The Bay tanker has a larger beam in proportion to her length than the European tanker. She also has her pump room arranged directly forward of the engine room instead of amidships as in the European ship.

Novelty is to be introduced into fishing on the other side of the Atlantic with the sailing of the trawler *HELDER* from Hull for the west coast of Greenland for Aalesund where she will pick up a fleet of motorboats on her way to the fishing grounds. Line fishing will be conducted from these boats and their catches will be transferred to the trawler which has a refrigerating plant, to be frozen for transport to the British markets.

Spedding Shipbuilding Co., Baltimore, Md., is completing an 87 ft. motor towboat for G. F. Pehinos of Philadelphia. This vessel is powered with an Ingersoll-Rand Diesel of 400 hp.



Diesel tanker Margareta built for coastwise transportation of gasoline in Europe makes interesting contrast with San Francisco Bay tankers

Sketches and Working of Oil Engines*

Practical Considerations Underlying the Injection of Fuel Without the Use of Compressed Air

AS the characteristic which sharply distinguishes oil engines from other internal combustion motors, the fuel injection process may be profitably studied from a number of different points of view. In order to force the oil into the cylinder at a time when compression has established a temperature suitable for combustion, some kind of pump is required to handle the oil and some sort of spraying device is necessary to project it into the cylinder.

However, the mere transfer of the oil from the outside source to the interior of the cylinder under compression is not sufficient, as the oil must be introduced in such a form that it will burn at an exceedingly rapid rate. Sometimes the pump itself is actively concerned in this preparatory process as is the case with some so-called "solid-injection" engines operating without the use of compressed air or primary explosion chambers. Sometimes the pump has nothing to do with injection, particularly when the oil charge is conveyed into the cylinder by the blast of compressed air used in air-injection machines. At the same time the oil entering the cylinder at each firing stroke must be accurately measured, for by this means alone may the output and speed of the machine be regulated.

Thousands of forms have been devised for the orifice or nozzle by means of which the oil is projected into the combustion space. Each one of them represents a good or a bad solution of a problem stated approximately as follows: How can a small portion of cold liquid fuel be prepared for combustion and consumed in an interval of time measured sometimes by hundredths, sometimes by thousandths of a second? The degree of promptness in the combustion attained by the designer and realized during the life of the engine by the operating engineer appears to be one of those vital points on which oil engine success or failure depends.

Intimately bound up with the general problem of fuel injection and burning is the shape of the combustion space. When the liquid fuel is directly injected without the use of compressed air, the influence of the combustion space contours does not seem to be as prominent as is the case when the fuel enters under its own hydraulic pressure. The use of injection air probably solves most injection problems at a single sweep, but it raises a problem outside of the combustion space—the injection air compressor. Volumes might be written on these subjects; but in view of the lack of uniform opinion concerning them and of the impossibility of evaluating long-term operating results in exact engineering terms, the present treatment aims to show the student what to look for rather than to tell him too dogmatically what he will find.

When Dr. Diesel first conceived the idea of a compression-ignited injection engine, he probably regarded the process of consuming liquid fuel, or even coal-dust, in a red-hot atmosphere of compressed air as an exceedingly simple one. No one who had not previously thought the matter over could be expected to doubt that the fuel would merely have to be projected into the cylinder under a pressure sufficient to overcome the compression.

But to bring about combustion of any solid

or liquid substance, a certain amount of time-consuming preparation is necessary. Vaporization and gasification must precede inflammation and before vaporization can take place the substance must be both heated and spread out over a large surface. Only the surface of the substance is available for vaporization; all the particles situated in the interior of the mass, be it liquid or solid, must wait until the surface-particles surrounding them have gone out of the way. Quick heating also depends on spreading the body to be ignited over a large surface because by that means the avenues by which the heat may approach are multiplied and their length shortened. Without heat, of course, there can be no vaporization and without vaporization no combustion. Oil as oil cannot burn.

assumption that combustion does not begin until the piston has reached the top dead center, in view of the fact that the indicator card shows indisputable evidences of combustion until 40 deg. or more after the dead center. However, if it be assumed that the bulk of the charge is present in the cylinder 7 deg. before the dead center and that the bulk of it has been ignited 8 deg. afterwards, the result would still be the same as if 15 deg. had been set down as the interval between injection and combustion.

But 15 deg. in an engine running at 150 r.p.m. represents an exceedingly brief interval of time. It corresponds to $1/24$ of a revolution, of which there are $2\frac{1}{2}$ every second. Roughly speaking, the lapse of time between injection and combustion therefore equals $1/60$ of one second. If the engine were fitted with air injection the timing advance would be only 5 deg. and would reduce the injection-combustion lag to $1/180$ sec. assuming the same speed of rotation. In a Maybach automotive Diesel engine running at 1200 r.p.m. with air injection the interval would theoretically be $\frac{1}{6}$ as small, amounting actually to less than $1/1000$ sec.

But to continue with the illustrative example originally set up, $1/60$ of a second will serve sufficiently well. Within that space of time the 1-in. sphere of oil must be dissipated into a vapor and its chemical union with the oxygen in the combustion space (ignition) started.

Merely to vaporize 0.017 lb. of oil from the surface of a 1-in. sphere offering 0.0218 sq. ft. of surface within $1/60$ sec. is an impossibility, implying as it does a vaporization rate of 168,300 lb. per sq. ft. per hr. Nor could an amount of heat required for the process enter the mass of oil through so small a surface area in the time available, no matter how hot the surrounding atmosphere might be.

Suppose now that the engine atomizer succeeds in breaking the charge up into eight spheres $\frac{1}{2}$ in. diameter each. Together, they would still represent the same quantity as the single 1-in. diameter sphere, but their aggregate surface would have been increased to 0.0436 sq. ft. of surface (Fig. 3), whereas one billion 0.001-in. spheres would come somewhere near to meeting the requirements of vaporization, mixture-formation and burning by exposing a total of 21.82 sq. ft. of surface to the action of the heated air of the combustion space. Owing to the fact that spheres of so minute a mass will not penetrate very far from the nozzle producing them, means are often provided for setting up air currents in the combustion space and thereby scattering the microscopic droplets far and wide. Unless this is done, they are apt to become enshrouded in the oil vapors which they themselves give off and thus defeat the very object of fine atomization. With an aggregate surface of 21.82 sq. ft. available, the rate of vaporization should be around 16.83 lb./sq.ft./hr., a value which ordinary experience with boiling oil indicates to be reasonable.

To make a billion droplets out of a single drop in $1/60$ sec. requires a quantity of mechanical energy which it is difficult to estimate on a theoretical basis, involving as it does such matters as surface tension, acceleration, and the like. However, the hydraulic pressures at which successful airless-injection sprays are known to operate do give a clue on which an estimate of the mechanical energy may be based. Neglecting the hydraulic efficiency of the spraying device, the mechanical

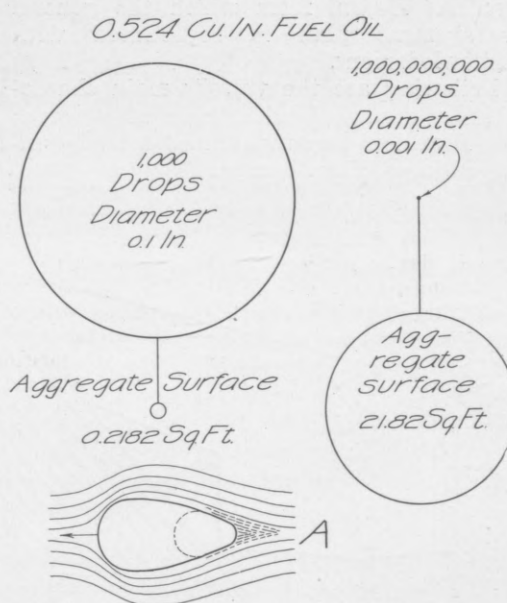


Fig. 3. Atomization of fuel oil

In an injection engine running at normal speed the time available for carrying out these processes on a particle of liquid oil does not often exceed $1/50$ sec. At the beginning of that interval the oil exists as a cold dense mass and at the end of it the oil must have been converted into a true vapor (not merely a fog) capable of uniting with the oxygen in the cylinder and producing a flame.

To illustrate: a 4-cycle engine cylinder developing 185 hp. at 150 r.p.m. requires a scant third of an ounce of fuel (0.017 lb., more exactly) to be injected at each working stroke. As a single sphere this would have a diameter very nearly equal to one inch exposing a surface of 3.142 sq. in. or 0.0218 sq. ft. for heating and vaporization.

The amount of time available for these processes may be roughly estimated on the basis of the timing advance, particularly in the case of airless-injection machines operating with fluid injection pressures of many thousands of pounds per square inch. As it does not take very long to move 0.017 lb. of oil with so much pressure behind it, the assumption that all the oil is already present in the cylinder before combustion begins may serve as a reasonably close approximation. In fact the value of this illustration will not be impaired if it is assumed that the complete charge of oil is already in the cylinder at the beginning of the fuel valve's opening—say 15 deg. ahead of the dead center.

A further approximation is involved in the

*Summary of a course of instruction at the Polytechnic Institute, Brooklyn, N. Y., by Julius Kuttner, B. Sc. Licensed Chief Engineer, Associate Editor of MOTORSHIP. This is the second chapter, being a revision of the installment published in the February, 1925 issue.

energy consumed per injected charge of oil is the same as would be required to pump the oil back through the spraying orifice from the combustion space into the supply line.

A good many airless injection sprays are operated at a pressure for which the round figure of 4500 lb. per sq. in. may be set down. In the case of the 180-hp. cylinder requiring 0.017 lb. of oil per charge the power required for spraying each one would be the same as that required to deliver it from the combustion space pressure (400 lb. per sq. in.) back into the oil supply pipe at 4500 lb. The pressure difference amounts to 4100 lb. per sq. in. and is equivalent to a head of oil about 11,000 ft. in height. Elevating 0.017 lb. of oil for this distance requires $(11,000 \times 0.017)$ or 187 foot pounds of energy. Expended within a period of time $1/60$ sec. in length, this number of pounds-feet corresponds to the exertion of close to 2 hp. In engines running at 10,000 lb. per sq. in. injection pressure, the instantaneous rate at which power is applied to the oil charge may reach 5 hp. That seems like an enormous amount of violence (when it is remembered that 33,000 ft. lbs. per min. = 1 hp.) to inflict on a dribble of oil as big as a man's thumb, but it helps to assist the imagination in picturing a process by which this oil may be subdivided a billion times within $1/60$ sec.

Curiously enough, injection-horsepower figures not differing materially from the above are arrived at when analogous calculations are made for air-injection engines. In the latter case the normal capacity of the injection air compressor and the blast pressure may serve as a basis for the estimates. The significant fact of the matter seems to be that there is no use in trying to produce an adequate break-up of the oil with less than a certain amount of energy, irrespective of whether it is hydraulically or pneumatically supplied.

No precise experimental data appear to be available concerning the hydraulic-aerodynamic process by which the energy necessary to produce atomization is applied; it is possible, however, to form an approximate mental picture of it by remembering that practically all atomizing phenomena depend upon rapid relative motion between oil particles and the gaseous medium surrounding them.

If a drop of oil moves along a current of air with the same direction and velocity, there is no tendency for it to break it up and it will be drawn together into the form of a sphere by the forces of its own surface tension. However, as soon as the oil drop is exposed to a current of air, it tends to assume a streamline shape, as approximately sketched in Fig. 3A. According to the principles of aerodynamics, the thicker part of the egg-shaped body will be headed into the wind and will suffer a rise in pressure at its forward end. The trailing slender portion is exposed to an under-pressure found in the wake of all bodies moving through a fluid medium and indicated in the sketch by means of the dotted stream lines.

The larger the drop, the flabbier it is and the greater will be the tendency to subdivide as indicated by the dotted contour (Fig. 3A) in response to the suction pull exerted on its after end. Finally yielding to this, it subdivides into smaller drops, reminiscent of the amoeba's reproductive process. Given a sufficiently high air velocity, the subdividing process continues while the surface tension and consequent toughness of each progressively smaller drop size increases until no further subdivision is possible.

It is immaterial, so far as this explanation is concerned, whether the oil drops are projected into relatively still air or whether they are suddenly swept forward by a gust of moving air. It is the relative motion between the oil drops and the air that causes the break-up. In "solid-injection" engines only the kinetic energy of the oil drops may be drawn upon for

this purpose unless air currents are set up in the cylinder by a displacing action of the piston or by initial combustion due to the early burning of a fraction of the oil charge. In Diesel engines fitted with a compressor for fuel injection an indefinite amount of motion is capable of being set up between the air and oil particles for atomizing purposes.

Except when poorly designed nozzles are used, the air puff which accompanies air injection agitates the contents of the combustion space in such a way that the fuel is widely distributed and each particle quickly finds the

vaporization in the time available. Although direct experimental measurement of the drop-size produced in oil engine sprays appears to be incomplete, evidence published to date* justifies the belief that drop diameters around 0.001 in. are actually obtained and that the aggregate surface corresponding to this drop-size is sufficient for the vaporization requirements met with in the oil engines of today. The problem seems to center not about a further pulverization of the oil, but in separating the particles far enough to permit the combustion air to get at all of them.

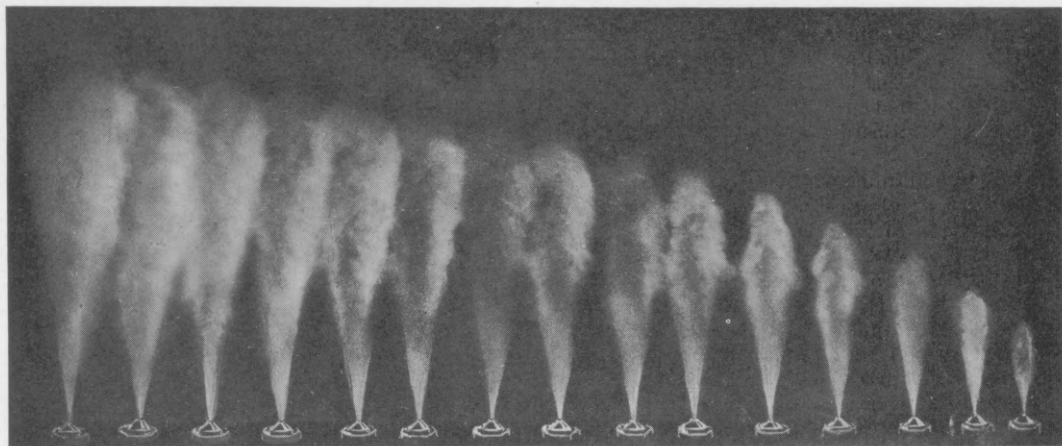


Fig. 4. Oil sprayed at 800-lb. pressure into nitrogen compressed to 300 lb. per sq. in.

oxygen which it needs for prompt and complete combustion. It therefore seems feasible to employ air injection on engines with relatively flat or shallow combustion spaces as the whirling motion set up by the air puff is apparently not much impeded by contact with the piston crown and cylinder head surfaces. It is possible, of course, to produce a combustion space of so irregular a shape (Fig. 9C) that the turbulence of the air puff will not completely reach all parts of it. When that is the case combustion is apt to be sluggish and forces the use of increased timing-advance in order to obtain the amount of combustion required for the full power of the engine. Indicator cards (Fig. 13A) exhibit the characteristic early-timing peak and the "fat" toe attesting the combustion of fuel late in the

Experiments made by Robertson Matthews at the Langley Memorial Aeronautical Laboratory and reported by H. E. Miller and E. G. Beardsley in Report No. 222 of the National Advisory Committee for Aeronautics (1926) yielded groups of spray photographs taken at the rate of 4000 per second. In order to duplicate actual engine conditions as closely as possible the spray was projected into a chamber filled with nitrogen gas compressed to 300 lb. per sq. in. and less, while heavy plate glass windows at the sides of the chamber permitted the sprays to be photographed on a rapidly moving film. The actual photographs are reproduced in Fig. 4.

A study of the dense cloudy masses produced by the atomizer appears to give a good indication of how thoroughly the body of the oil

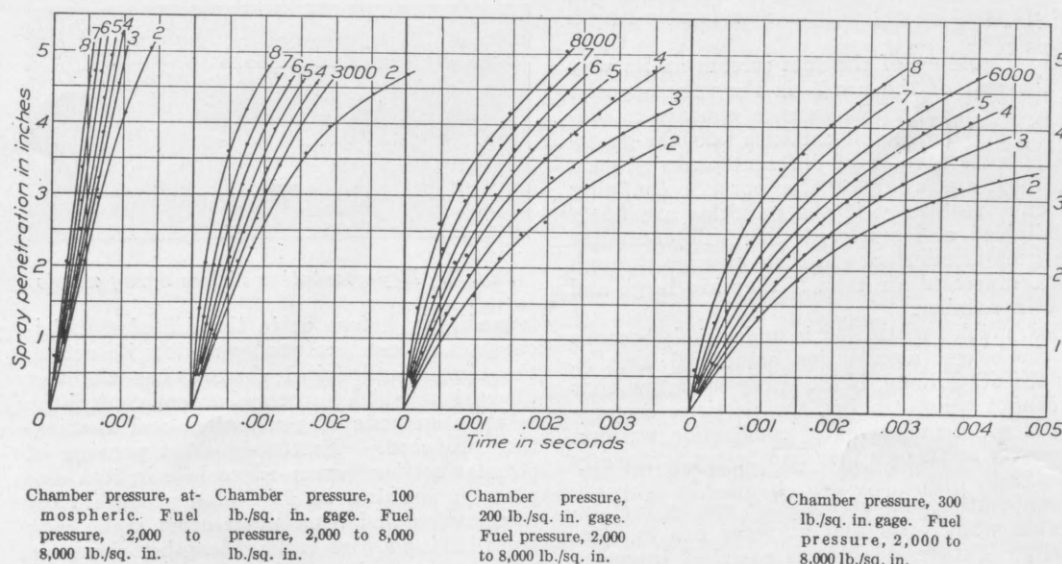


Fig. 5. Langley Field spray penetration experiments

stroke, while tests show the fuel consumption as well as the amount of heat transmitted through the cylinder and piston walls to be high.

It would probably be a mistake to infer that the airless fuel injection problem is entirely solved when a spray has been produced which subdivides the oil into sufficiently fine particles and which therefore exposes an aggregate of oil surface sufficient to permit of heating and

* In a recent article entitled "Atomization of Liquid Fuels," Dr. R. Kuehn describes a fuel atomizer set up in an experimental rig fitted with a shutter for intercepting a portion of the spray and making it impinge on a plate. By carefully measuring the increase in weight of the plate and counting the number of drops lodged on it, their individual size was determined. As the experiments were carried out in atmospheric air and with injection pressures not exceeding 583 lb. per sq. in., the smallest drop size measured by Dr. Kuehn—0.0018 in.—is probably greater than that actually occurring when oil sprays at 4,000 lb. per sq. in. or more are projected into compressed air at 350 lb. per sq. in.—*Der Motorwagen*, Oct. 10 and 20, Nov. 30, 1924.

fog displaces the surrounding air and virtually excludes it from contact with the bulk of its more central portion. It favors the belief that such a spray would hang almost motionless in still air and would burn only at a slow rate of speed. It is probable that the combustion gases themselves would tend to enshroud the remaining interior oil particles and might even extinguish the flame before it can penetrate very far into the body of the spray.

It is apparent from the Langely Aeronautical Laboratory experiments that the distance moved by the tip of the spray decreases with higher compression pressures prevailing in the chamber and increases with the fuel injection pressure. Although deep penetration is an advantage so far as generality of distribution is concerned, it is troublesome in making the oil lodge on the metallic surfaces surrounding the combustion space. Even in the case of hot-surface engines, actual lodgement of liquid fuel drops on the metal appears greatly to hamper their prompt oxidation and to favor the deposition of coke and mineral substances.

The experimental data cited above includes curves for spray tip penetration and velocity calculated from the known speed of the film, the time-interval between the photographic exposures, and the dimension-scale of the pictures. The curves reproduced in Fig. 5 show what appears to be a distinct limitation in the depth of penetration obtainable with the straight nozzle used, even with fuel pressures as high as 8000 lb. per sq. in.

Throughout the tests a single cylindrical nozzle having a bore of 0.007 in. was used. The axial length of the nozzle is not reported although in the opinion of Dr. Büchner* this is a matter vitally affecting the depth of penetration. A translation of his statements bearing on this subject follows:

"When a fuel jet, under such a high pressure (2000-6000 lb. per sq. in.) is injected through a small opening into compressed air, it forms a cloud at a certain distance from the mouth of the nozzle. This distance—the striking or carrying distance of the spray—depends on the width or diameter of the channel leading to the exit in relation to its length and also on the velocity at which the fuel leaves the nozzle. In order therefore to increase the carrying distance, the length of the injection channel with respect to its diameter must be as great as possible, or, in other words, the jet must be guided by a considerable length of channel."

Good guiding of the fuel stream on its way to the exit of the nozzle is the very opposite of atomization, whose essence appears to consist in making the oil particles take the greatest possible number of different paths as soon as they are clear of the nozzle's confining effect. Naturally if the particles are finely subdivided and scattered they will encounter far greater resistance in their passage through the compressed air than if they are large and few in number.

Too much penetration is undesirable because of the coarse atomization associated with it. On the other hand, if the spray is so fine that it cannot penetrate far, the particles composing it will be deprived of combustion air just as surely as though they had been too coarsely atomized.

Penetration and atomization are to fuel injection what volts and amperes are to electricity. Penetration is the so-called intensity factor, whereas atomization may be considered as the mass or quantity factor. The most powerful electric current is the one having the highest product of (volts $\times$ amperes) and the most successful oil injection system is the one which combines finest atomization with greatest completeness of penetration.

Continual reference to these two fundamentals of oil engine injection systems has been

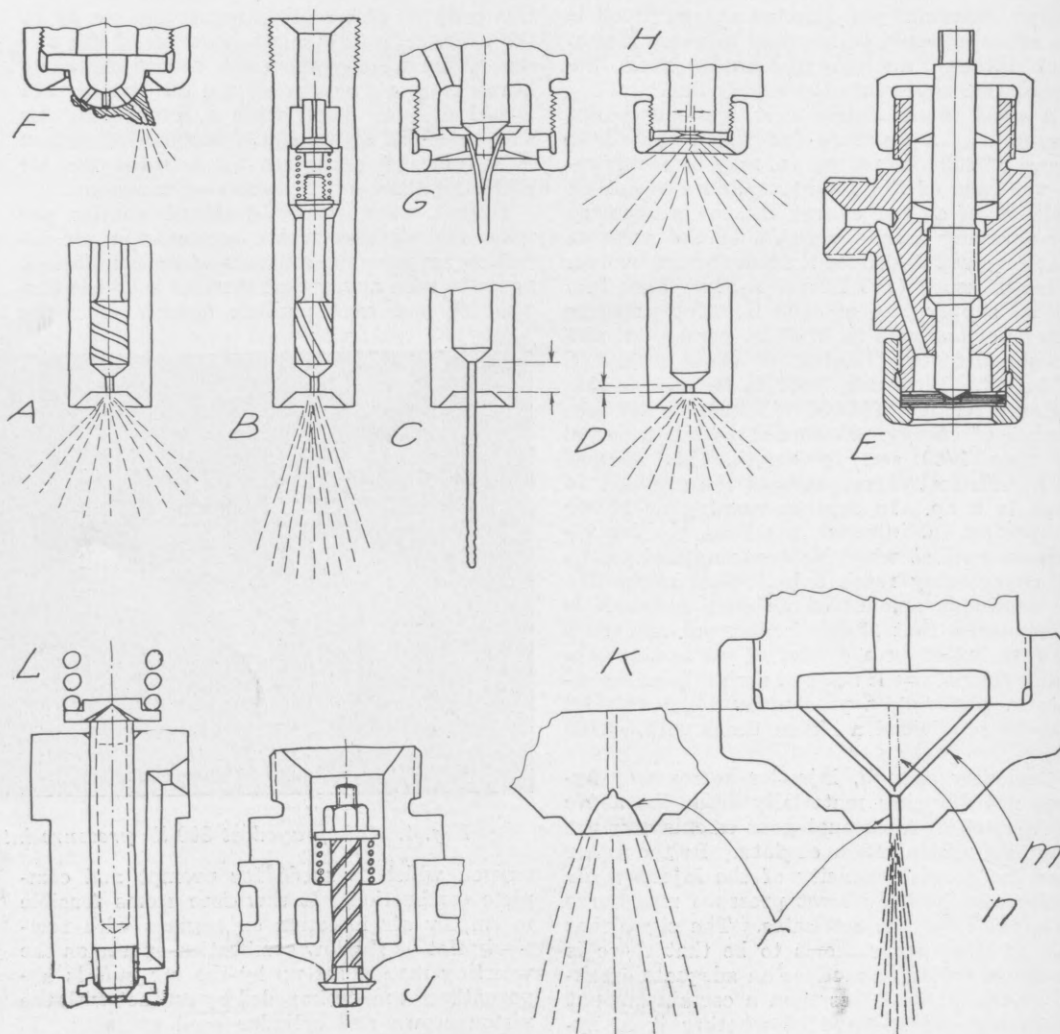


Fig. 6. Various forms of spray tips used for airless-injection systems found in practice

found useful in judging all the elements entering into their operation. Among the most important details is the orifice or opening by which the fuel enters the engine cylinder. By far the great majority of these openings consist of plain cylindrical passages of small bore formed simply by drilling (Fig. 6C). Although valves, spirals and other devices placed

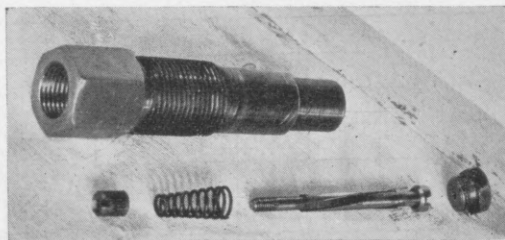


Fig. 7. Representative airless spray nozzle

immediately before or in the drilled cylindrical passage can profoundly modify its action, the simple cylindrical channel has the two dimensions which in themselves can control the relative amounts of penetration and atomization produced. Extremely short passage of circular section (sharp-edged hole in thin diaphragm showing in Fig. 6G) produce most atomization and least penetration while long holes having a high ratio of length to diameter (Fig. 6C) yield smooth, solid, wire-like jets in which drop formation begins only at a long distance from the mouth.

Long cylindrical nozzles can be easily modified to give more or less pronounced atomization by placing spiral guiding passages immediately ahead of them, the combination thus produced being so common and widely used that it might almost be termed the standard airless injection nozzle (Fig. 6B). Its mechanical construction is based on the use of drills having two different diameters and on

inserting a spirally fluted solid cylinder in the larger of the two. In flowing through the flutes the oil is given a decided rotary motion which is largely retained by the liquid in its passage through the fine drilled hole. Upon leaving the latter, the centrifugal force of the rotating oil particles tends to scatter them radially. This component of motion, being at right angles to the axis of the jet, produces the conical spray well known to oil engine technicians. A photographic view of a characteristic nozzle of this general design is reproduced in Fig. 7.

Assuming that the length of the fine hole beyond the spiral remains unchanged, variations in the characteristics of this atomizer combination may be tabulated as follows:

Atomizer Combinations

STEEP SPIRAL	FLAT SPIRAL
Small Cone Angle	Wide Cone Angle
Deep Penetration	Shallow Penetration
Coarse Atomization	Fine Atomization

It is possible, of course, to obtain deeper penetration or finer atomization with special form of nozzles specially designed for either the one or the other specific purpose. However, there is reason for believing that the cylindrical nozzle with spiral guide is successful only in those engines having specially designed combustion spaces or otherwise arranged to assist the nozzle by turbulence and agitation set up in the combustion space. It is often found on surface-ignition machines.

In some engines the fuel jet is not the primary atomizing agency, this function being taken over by the explosion of a certain part of the fuel in a so-called pre-combustion chamber (Figs. 9 A, B, and D) connected to the main cylinder space by holes of varying size. As the rush of gases through the holes is largely depended upon to break up and mix the fuel, the action of the nozzle by which the fuel is in-

* Jahrbuch der Brennkrafttechnischen Gesellschaft, Vol. V, 1924.

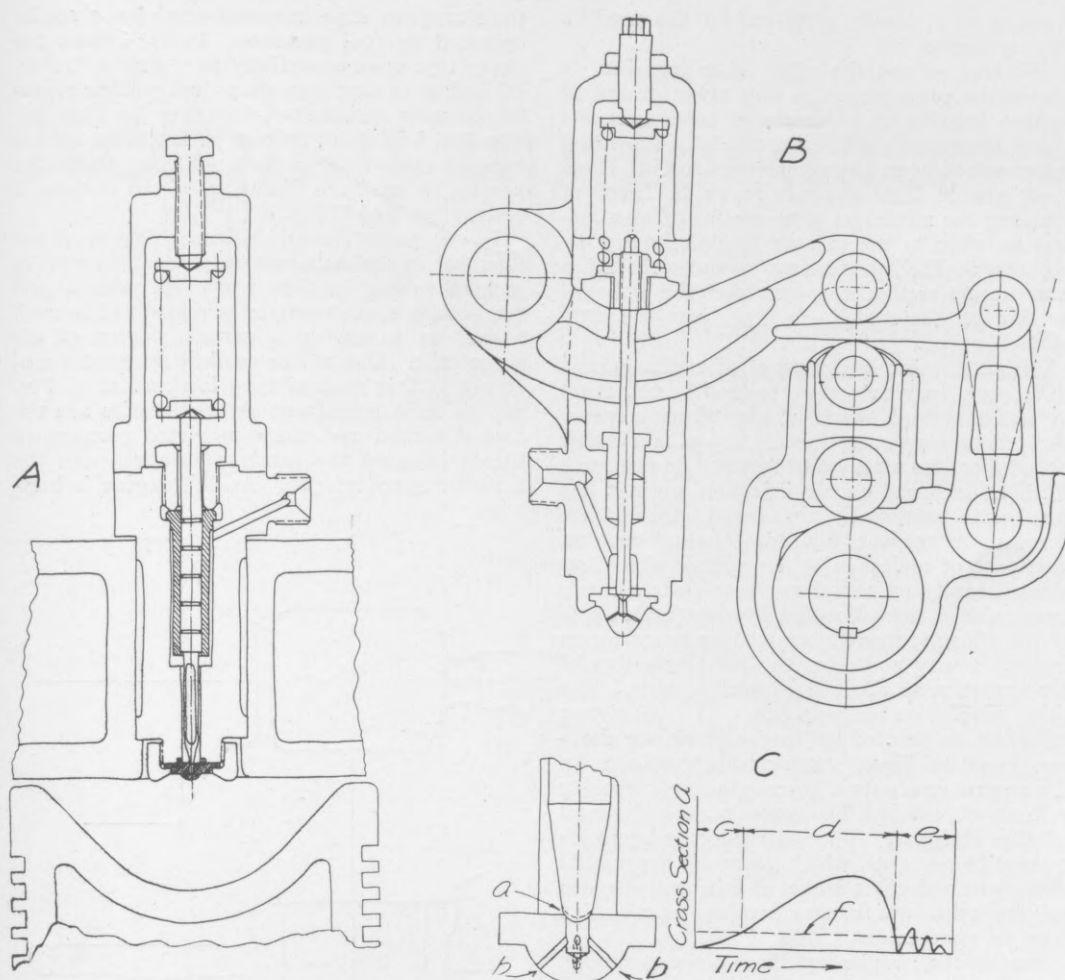


Fig. 8. Hydraulic (A) and mechanical (B) spray valves with deep piston dish

produced into the pre-combustion chamber is probably not so important. It is therefore not surprising to find such engines equipped with nozzles having no specially pronounced atomizing effect. An effort is actually made in some cases of this kind to suppress atomization altogether, which, of course, can easily be done by omitting the spiral or equivalent member and lengthening the cylindrical discharge hole (Fig. 6C). An even more wire-like stream of oil is produced when a needle is inserted in the hole to produce what is really an annular orifice. The effect of this expedient (Fig. 6G) in solidifying the jet has been widely demonstrated on all manner of jet apparatus, from fuel sprays up to needle-governed pelton wheel nozzles with an outlet diameter of three inches.

By far the largest number of airless sprays in service are fitted with a non-return check valve (Figs. 6C and J). Sometimes the moving spring-loaded valve member is itself a part of the spray orifice, in which case its manner of working is readily comprehensible (Fig. 6J).

Owing to the high pressures shown to be essential for pulverizing the oil, the cross sections of all atomizing nozzles must be exceedingly minute in order that the amount of oil going into the engine cylinder may be kept under control. To produce accurately orifices of fixed cross section, drilling a 0.006-in. diameter hole, for instance, is undesirable both from manufacturing and maintenance points of view and for many purposes 0.006 in. is still far too large. The yielding orifice, on the other hand, automatically adjusts itself to the proper opening, even though this be so minute as to defy ordinary machining and measuring methods.

It is not uncommon to find non-return valves placed far enough away from the actual orifice to prevent them from being regarded as an actual part of the nozzle, but not so far as to eliminate them as a factor entering into the spray formation. An examination of the atomizer shown in Fig. 7, for instance, shows

that the spiral flutes are formed on the stem of the non-return valve, whose head is interposed between the flutes and the actual orifice. There can be little doubt that the flutes affect the spray, and if they do, the valve and its seat must also affect it, because the latter are closer to the spray than the flutes. In the nozzle shown in Fig. 6B the check valve is located in such a way as to preclude its having a direct effect on the formation of the spray. It is equipped with a spring strong enough only to insure the positive seating of the valve and exerting no profound effect on the pressure of the oil or the cross section through which it travels.

An elaborately devised valve having the mixed functions of a non-return valve and spray former is illustrated in Fig. 8A. However, as the oil makes a sudden bend after leaving the needle seat, it is apparent that the latter is not the sole factor influencing the formation of the spray. Similar considerations apply to the valves belonging to this general class, in which the spray is affected by the combined action of a seat-orifice and the whirling produced by tangential passages. The sample shown in Fig. 10J is similar in this respect, while the valves illustrated at Fig. 6L and E probably come nearest to being examples of sprays determined entirely by valve seat characteristics.

In the case of the experimental nozzle Fig. 6E spring action is furnished by the flexibility of a sheaf of diaphragms having a single hole at the center and pressed against the end of an adjustable conical-ended spindle. When the pressure inside the valve becomes great enough to exceed the force originally exerted by screwing the spindle against the diaphragm hole, the plates deflect by an additional minute amount and permit oil to escape in a high state of atomization.

Its atomizing efficiency should be high because the ring-shaped orifice is also the exit cross section and the full energy liberated therein is apparently devoted to nothing but

projecting the fluid into space. Compare this with arrangements like the one sketched in Fig. 8C, where the high-velocity fuel-stream escaping past the needle seat largely dissipates itself in striking the bottom of the drilled hole below the needle tip.

The check-valve type of atomizer (Fig. 6B, 8A) is most commonly used in connection with fuel pumps producing momentary pressure impulses suitably regulated as to timing and quantity. It is frequently claimed that back-flow of gases from the cylinder into the fuel line must be positively prevented because gas or air-binding is fatal to the action of any impulse-type fuel pump. All the more surprising, therefore, is the fact that one of the most prominent European manufacturers of airless injection engines is marketing them without any kind of non-return device placed between the spraying orifice and the discharge check valve on the fuel pump. An atomizer of this kind is illustrated in Fig. 6H. The secret of its success probably lies in the fact that it is connected by a simple goose-neck to the fuel pump, of which one is provided for each cylinder and located in a standard position with respect to the fuel valve. As the cross-section of the tube is also kept small, the viscosity of the fuel probably assists in preventing the accumulation of air or gas bubbles near the top of the goose-neck. Before starting the engine the tube can be filled "solid" with fuel and is prevented from draining into the cylinder by the combined action of the viscosity of the fuel and the absence of a vent.

One of the most serious objections to the use of any kind of a non-return device or check valve arises from the fact that it can trap a certain amount of oil under pressure in the length of tubing leading to the fuel pump discharge valve. Unless the check valve in the atomizer is absolutely tight, the trapped oil slowly oozes out of the spray tip where it is cracked and carbonized. "After-drip" is the name by which this phenomenon is often designated. Its immediate consequence is to produce foul combustion and ultimately to put the cylinder out of commission altogether. Although the heavy hydraulic pressure generally prevents a complete stoppage of the oil, it cannot hinder the formation crusts as sketched in Fig. 6F.

The operation of non-return valves in the atomizers discussed so far is really equivalent to that of a hydraulic valve gear, in which the pressure impulse replaces cams and push rods for actuating the movable member. In some engines, as a matter of fact, the atomizer is fitted with a cam-operated fuel admission valve (Fig. 8B) capable of tapping off the required amounts of fuel oil from a supply of oil stored under suitable pressure. It would probably be difficult to analyze in what essential respects a hydraulically operated atomizer-admission valve differs from a mechanically actuated one. Structural differences of considerable importance are of course apparent: chief among these might be mentioned the arrangement of the fuel pumps and supply piping which feeds the atomizers. When the valve is opened by pressure difference originating in the fuel pump, exterior mechanical gear can be dispensed with; on the other hand, the fuel pump drive must be such as to permit of accurately measuring and timing each fuel impulse transmitted to the cylinder. On airless injection engines fitted with mechanically operated spray valves (Fig. 8B) individual mechanical drive susceptible of timing and quantity variation is provided, while all of the valves are supplied from a branching oil main kept under high pressure by a fuel pump continuously delivering an over-supply past a spring-loaded pressure-regulating valve. Although mechanically-driven fuel valves drawing from a "common rail" pressure supply are almost universally found on engines not fitted for air agitation in the combustion

space, there appears to be no reason why this fuel injection system should not be so used. In fact the opinion is held in some quarters that any successful atomizer could be interchangeably operated by hydraulic or mechanical means without seriously affecting it. This would apply, of course, only to those atomizers in which the valve does not form a definite part of the spraying orifice, as is the case with the majority of those in service today.

A system of fine passages capable of producing a spray may have nothing but fixed and unvariable cross-sections throughout, this being illustrated by many of the nozzles sketched in Fig. 6. Although devices belonging to this class are naturally capable of being adjusted after being removed from the engine, the cross-sections through which the oil can flow remain unchanged during the injection period. Non-return valves, such as the one fitted to the nozzle in sketch 6B generally afford an opening considerably greater than the minimum cross-section and as they are quite commonly loaded with springs of only nominal tension, their effect on the formation of the spray may be neglected.

It is the minimum cross-section at which the maximum velocity energy of the flowing oil is developed.

Energy in large quantities available at the point of atomization is probably the greatest single factor entering into the production of a spray, as has already been discussed in con-

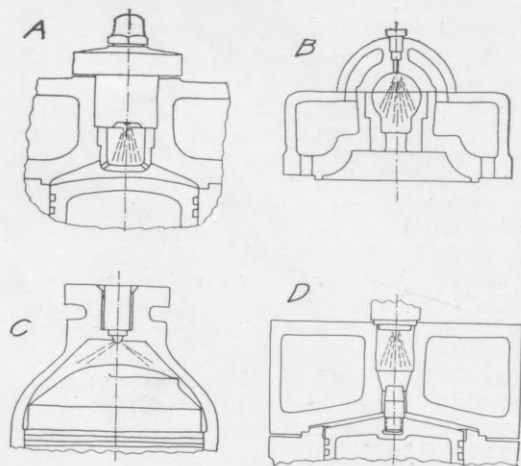


Fig. 9. Some characteristic combustion spaces

siderable detail. It would therefore seem to follow as a natural conclusion that the minimum cross-section of any fixed, hydraulically or mechanically operated atomizer should be as close as possible to the point where the spray is wanted (Fig. 6, E, L, and J). If there are larger cross-sections between the minimum one and the outlet to the engine cylinder, that is, if the final outlet is not the smallest one, it follows that the velocity energy developed in the exit orifice will be less than that liberated in the minimum cross-section. It would be less even if the oil had suffered no drop in pressure while passing through the minimum cross-section, but as this loss of pressure is considerable, the weakening of the spray at the final exit is decidedly more than proportional to the ratio between the exit and minimum cross-section.

In Fig. 8C, showing an enlarged view of the atomizer sketched at Fig. 8A, a diagrammatic illustration of this condition is presented. As the combined area of the spraying orifices *b* is less than that of the needle seat *a*, a certain amount of time, represented by *c* on the needle-lift curve, must elapse before the full pressure of the fuel can build up in the drilled holes *b*. During that period the spray issuing from *b* is imperfect. The line designated *f* represents the total area through the holes *b*. For the interval represented by *d* the needle seat area exceeds the sum of the areas *b*, with the result that the latter are then subject to the full fuel pressure. A condition similar to that of

c exists at *e*, towards the end of the needle's closing period.

Whether or not the effect here described is of serious consequence in any given design of engine depends on a variety of conditions and there are many engines successfully operating today which seem none the worse for it. However, simple logic appears to be in favor of locating the minimum cross-section of an atomizer as close to the exit as possible, many designers, in fact, preferring to make the minimum cross-section the exit for the sake of getting all the spraying energy into the combustion space.

Although some designers of oil engine sprays have been very reluctant to modify the more or less standard shape of the Diesel combustion space consisting essentially of a shallow round dish, the attempt to retain it in the same form as is found on air injection engines has been quite universally abandoned. One of the three main reasons for this—the serious impairment of airless-injection sprays which impinge heavily on metal surfaces—has already been pointed out. Mention has also been made of the effort to modify combustion space forms in such a way as to further the production of air currents at the end of compression. The third reason, or perhaps cause, is that airless injection, as pointed out in the preceding chapter, requires lower compression pressure in the engine and puts a correspondingly greater volume of combustion space at the disposal of the designer. The difference is approximately 11 per cent, which generally represents enough actual cubic inches of combustion space volume with which considerable modification may be undertaken.

One of the simplest of these consists merely in giving the piston crown a deeper dish than is customary with air less injection engines (Fig. 8A). In this case the fuel spray is placed on the cylinder centerline and produces a spray of substantially conical contour. In such engines marks and deposits found inside the piston dish show that only the tip of the spray has penetrated that far. It is questionable, however, in view of the research data on spray penetration, whether anything like an appreciable percentage of the fuel really comes in contact with the piston crown. Cross-sections of this general type of spray arrangement frequently show jets splashing copiously over the piston surface; it is probable that these are drawn from imagination rather than from life. At any rate it is probable that the deeply dished piston really does accomplish its object of preventing excessive fuel impingement on the piston surface. This view is supported by the phenomenally low rate of fuel consumption reported for these machines (0.37 lb. per b.h.p. per hr.) which could hardly be attained if the jets would really bespatter the piston crown as indicated on frequently published fanciful sketches.

The generally conical contour of the spray used on the deep-dish piston engines is produced in most cases by a sheaf of five sprays formed by simple cylindrical orifices similar to the one shown in Fig. 8A. Owing to the fact that no spirals are used with these orifices and that the flow of oil over the seat of the valve probably exerts little influence on the formation of the spray, five jet cones of relatively slender angle are probably produced. It is believed that these five orifices are nearly enough similar to those produced in the Langley Memorial Laboratory to make the photographs of Fig. 4 fairly representative of them. Subdivision of this spray into five integral units probably makes a total aggregate surface of oil available which would be difficult to obtain by means of a single orifice. It seems to be a peculiar coincidence that both American and European designers arrived at the number five apparently independently of each other and it is particularly interesting to note that whereas on this side of the water a mechanically operated spray valve was used,

the European experimenters employed a needle operated by fuel pressure. In both cases the spray tips were essentially as sketched in Fig. 8C and were used over deep-dish pistons represented with substantial accuracy by Fig. 8A. The fuel injection pressure in machines of this general class ranges from 4000 to 10,000 lb. per sq. in. and the diameter of the orifices is often close to 0.015 in.

Lower pressures and a lesser degree of refinement in the construction of the spray valve appear to be feasible when the piston and combustion space contours are modified in such a way as to set up a certain degree of air turbulence. One of the earliest successful machines of this general type is sketched in Fig. 10; its most prominent characteristics are the conical piston and the constricted passage or throat between the combustion space and the cylinder space proper. As the engine is hori-

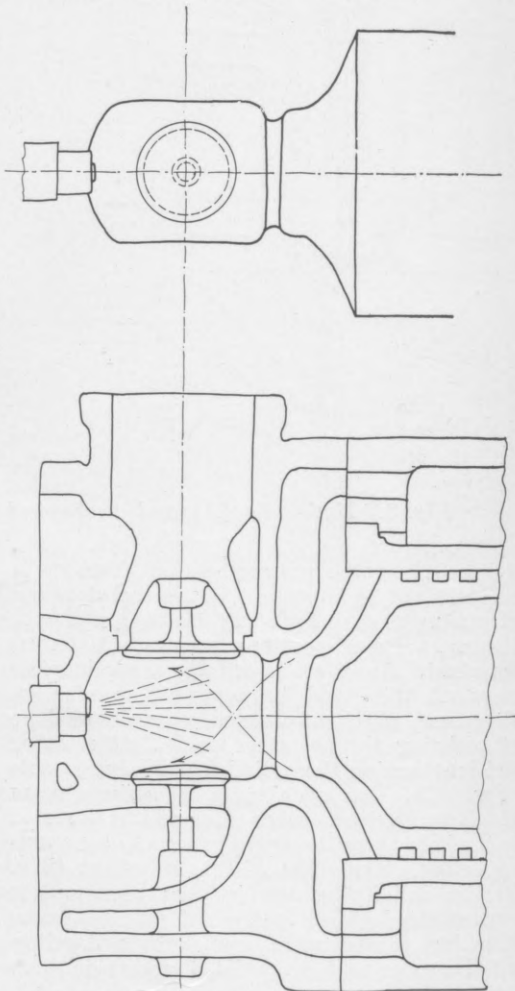


Fig. 10. Action of displacer piston

zontal with exhaust and inlet valves oppositely located on a vertical centerline at right angles to the cylinder axis, the resulting shape of the combustion space is approximately rectangular or prismatic, being bounded on its upper and lower surfaces by valve heads of approximately plane contour. Naturally a cross-section of this space taken at right angles to the cylinder axis shows an area considerably smaller than that of the piston head. Hence the latter is designed to approach the cylinder head within a few sixteenths of an inch at the inner dead center, while the clearance space is then represented almost entirely by the volume of the combustion chamber.

At a time when the piston has approached the head within a few inches, the compression of the air must also be accompanied by its bodily transference into the combustion space, a process which is fundamentally responsible for setting up the air current. By making the piston conical and adapting the cylinder head contour to suit, the slanting surfaces assist in the production of currents by guiding the flow of air and making it converge in a sort of a vortex at the entrance to the combustion space.

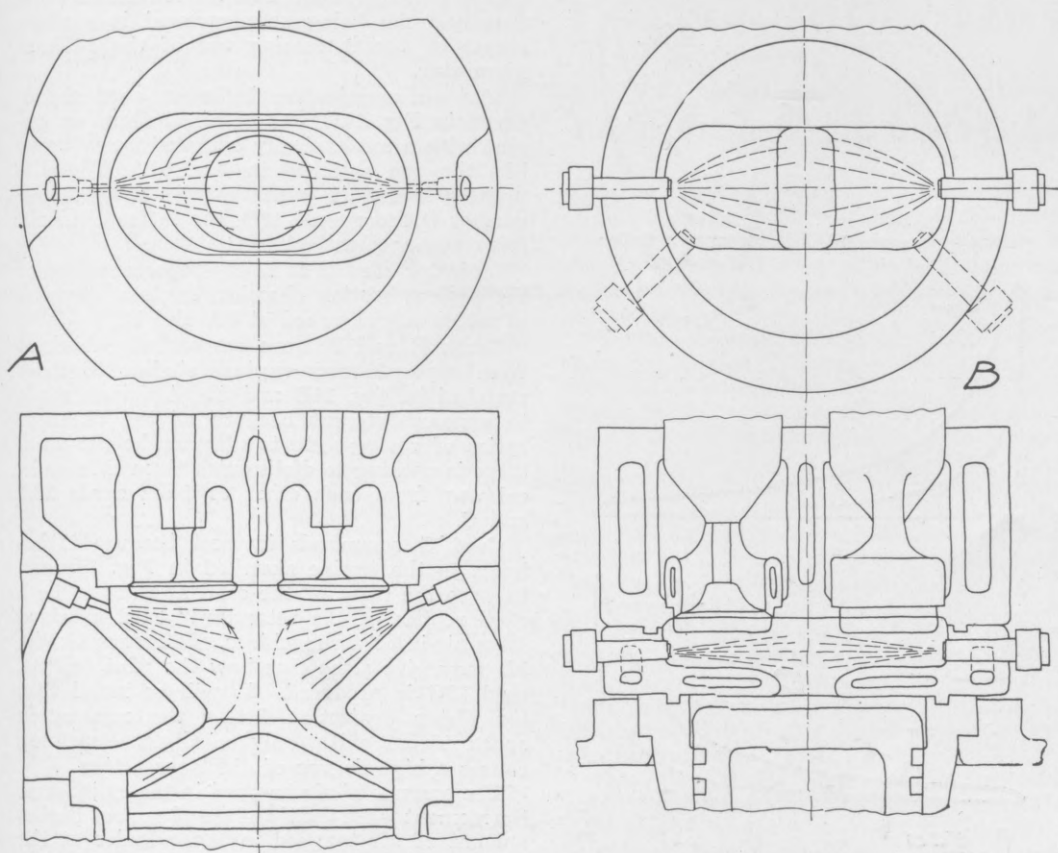


Fig. 11. Opposed-spray engines with colliding (A) and distributive (B) jets

It is there that it meets the advancing cloud of sprayed oil in head-on collision and diffuses it with a fair degree of completeness through the combustion space. It is probable that oppositeness of direction between the general air current and the sprayed oil charge makes possible the use of a more penetrative oil jet than would be practicable in still air. It is equivalent to lengthening the combustion space by an amount corresponding roughly to the relative travel between air and oil particles. The air current, in other words, tends to sweep the oil particles back in a direction away from the piston crown and thus to minimize impingement of oil on the metallic piston surface.

Before the advent of modern high-pressure sprays producing fleecy clouds of atomized oil, early designers were much occupied with the general problem of keeping the coarser and more penetrative jets from striking the relatively cold metal of the combustion space and piston crown. They found that the use of dual opposed sprays offered a solution. By arranging two simultaneous jets so that their center lines would intersect approximately at the center of the combustion space they found that the velocity of both sets of oil droplets could be checked long enough to allow time for vaporization and combustion. Regarding this as a matter of cardinal importance, they were apparently willing to mould the entire combustion shape to conform substantially to the geometric figure represented by two cones thrust through one another (Fig. 11A). At each conical apex is located one of the fuel jets while the rest of the figure allows exhaust and inlet valves and a throat passage leading to the cylinder to be accommodated.

Although, in the absence of real information as to what actually goes on, it is difficult to make a mental picture of what happens in engine combustion spaces, there is reason to believe that the action of the opposed sprays is not materially different from that described in connection with Fig. 10. When two symmetrical inclined jets are used, they probably produce a resultant cloud of spray traveling along the cylinder center line just as though it had been projected from a single atomizer centrally located at the far end of the combus-

tion space. The most essential difference appears to lie in the use of two jets instead of one, a feature which is always bound approximately to double the surface of oil available for vaporization and heating. At the same time the conical piston characterizing the displacer type engine rarely fails to set up beneficial air turbulence.

Considerations of a somewhat similar character possibly played a part in the design of the combustion chamber illustrated in Fig. 11B. Although seeming to depend on the mysterious inter-action of two opposed sprays, the designer himself will have none of it. The patent literature concerning this arrangement seems to make it clear that the intended purpose of the two sprays is solely to effect a degree of distribution unattainable with a single jet. As has already been indicated, there is a limit to the penetration obtainable with a given degree of atomization, no matter how high an injection pressure may be resorted to. Hence if the combustion space of a certain engine is bigger than can be penetrated by one such spray, there is nothing to do but to use more than one, the opposite-symmetrical location not being a primary consideration. According to this view, if the combustion space had a shape like a 90 deg. elbow, the jets would be located at 90 deg. instead of at 180 deg. (Fig. 11B). Additional color is given to this way of regarding the matter by the fact that the sprays are designed to produce a well-defined fan-shape, this being approximately suited to the combustion space contours outlined in the sketch.

Fan-shaped sprays for the flat combustion space referred to above and sketched in Fig. 8B are produced by twin oblique oil streams (Fig. 6K) strongly reminiscent of an acetylene burner tip. As the light check valve (not shown) placed ahead of the atomizer plays no definite part in the formation of the spray, this nozzle belongs to the so-called open variety. Formation of a substantially flat spray is due to the cancellation of the oil particles' motion in a direction at right angles to a plane passing symmetrically through the intersection of the twin oil passages. Practically all the component of motion across this plane

are neutralized and the fluid streams redirected to flow only in planes parallel to it. There is a distinct tendency for the spray to assume a curved outside contour, whose definition is said to be improved by the formed cavity r milled in the tip.

According to the claims made for this nozzle, it is highly efficient in converting the hydraulic energy of the fuel into atomizing and penetrating force, in view of the fact that no mechanical constriction, such as extremely fine bored holes or spring-loaded valve gaps are employed. Mean effective pressures up to 150 lb. per sq. in. are claimed to have been realized by such nozzles as these fitted to a combustion space like the one illustrated in Fig. 11B.

Dual sprays intended not for opposition purposes but rather to secure generality of distribution are the avowed basis of the arrangement sketched in Fig. 12A. The chief difference between this and the one just discussed appears to lie in the side-by-side location of the conical, as opposed to fan-shaped, jet. The total distance in front of the atomizer tip to the nearest cylinder metal on which fuel could impinge is probably the same as in Fig. 11B.

The combustion space shape which is probably least sensitive to variations in the fuel spray is the one resulting from the use of a so-called pre-combustion chamber (Fig. 9A). It is separated from the cylinder either by a series of holes of about $\frac{1}{4}$ in. diameter as in sketch A or by a single more or less constricted throat as in B and D. The common principle underlying the pre-combustion chamber seems that it permits of a measurable pressure difference to be set up between the ante-chamber and the main cylinder volume,

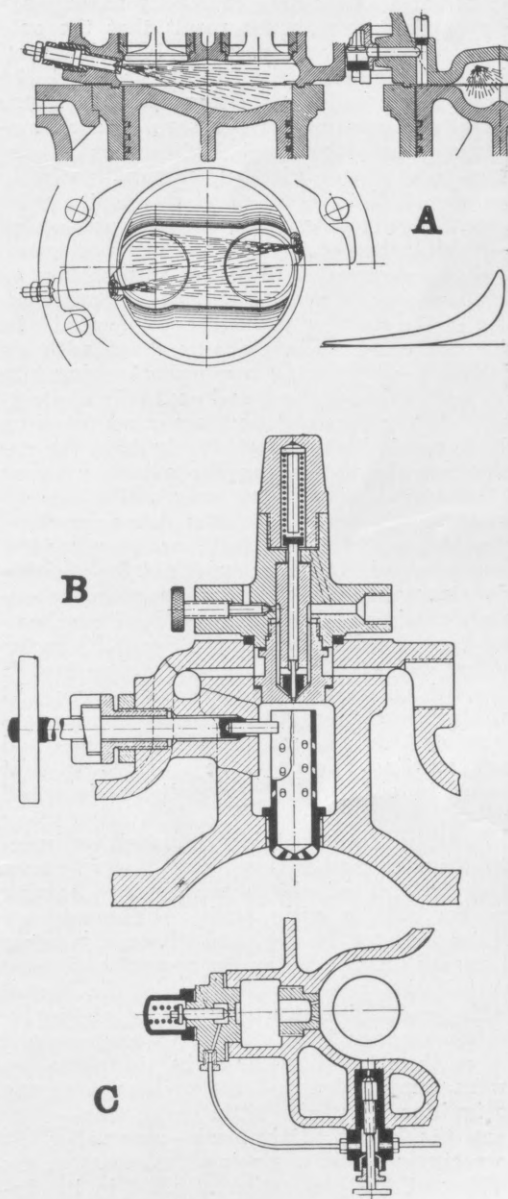


Fig. 12. Injection system details

as is clearly shown by indicator diagram H, Fig. 13. The latter are displaced cards taken with an indicator drive 90 deg. out of phase with the engine crank, one of them from the cylinder and the other from the combustion space. Two such cards are superimposed on one another in diagram H, where the vertically cross-hatched area represents in a general way the work of the gases performed in expelling the chamber contents into the main cylinder space. The engineer publishing this diagram (Fritz Modersohn, writing in *ZdVDI*, No. 23, Vol. 70, page 769) uses it as a basis for calculating the "injection work" performed and reaches the highly significant conclusion that this is one of the same order of magnitude as that calculated for air injection engines. It is particularly interesting to compare these results with the remarks made on spraying energy earlier in this chapter.

As is shown by the normal card for the pre-combustion engine (Fig. 13D), the pressure rise due to combustion does not appreciably exceed that established by compression, notwithstanding the fact that the fuel is injected with about the same degree of suddenness as that which seems to characterize other airless-injection indicator cards. This fact supports the belief that combustion within the chamber is partial, due to the lack of sufficient air to burn the fuel. Burning is completed after the piston begins to recede while the gases rush turbulently through the constricted neck. They are undoubtedly agitated considerably by the over-pressure created in the chamber by the preliminary combustion. Adjustments can be made on these engines in such a way that the net pressure rise effective on the piston just about balances the drop ordinarily accompanying expansion, with the result that the substantially horizontal pressure line shown on the indicator card (Fig. 13D) is produced. In order to secure safe starting at all temperatures, the compression pressure in such machines is sometimes set higher than in the open-type airless-injection engines, probably because of the cooling effect due to the relatively large metal surface—active water-cooled—which makes up the entire combustion space.

High compression pressures in machines of this kind can be avoided if a certain complication of the starting procedure is tolerated. In the one case the machine is fitted with an auxiliary oil spraying nozzle discharging into the main cylinder space and used only at starting. As the temperature there encountered by the spray is high enough for ignition the engine may be started on the auxiliary spray (Fig. 12C) and switched over to the regular spray discharging into the pre-combustion chamber as soon as a suitable temperature has been attained. Another expedient for starting low-compression pre-combustion chamber engines consists in drilling the walls of the chamber for a hand-screwed plug (Fig. 12B) in the hollow end of which a glowing "cigarette" is inserted before screwing the plug home and turning over the engine. However, on engines of fairly large size moderate compressions and safe starting appear to be obtained without resort to either of the expedients described above.

Indicator cards obtained from airless-injection engines mostly have sharp peaks because imperfections of the atomizing and mixing process require early timing. The advance varies between 13 deg. and 25 deg., whereas it rarely exceeds 7 deg. in normally-adjusted air-injection engines. Because of the peaked cards produced in the majority of airless injection engines it is difficult to compare and judge them. Obliterating the transition between compression and the pressure rise due to ignition, they give little or no clue—other than the height of the peak—concerning the correctness of the engine's adjustments or the quality of the combustion attained in it. Indicators are therefore not quite so generally used on engines of the airless-injection type

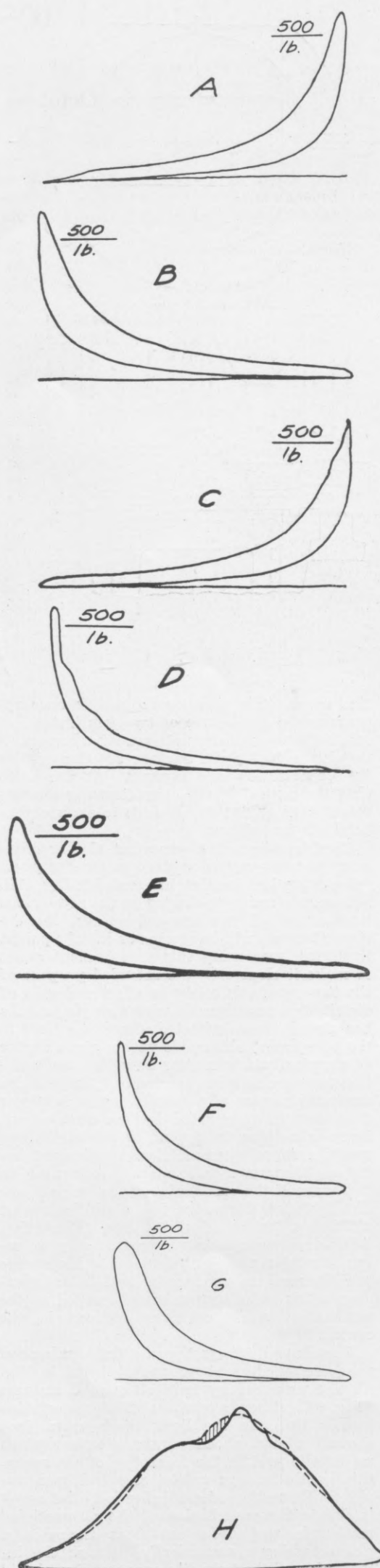


Fig. 13. Indicator cards as taken

except as a rough check on the maximum pressure and are being supplemented in modern plants by the increasing use of the exhaust pyrometer.

The airless-injection indicator card reproduced in Fig. 13B was obtained from an engine with a mechanically operated spray valve like the one sketched in Fig. 8B. There is nothing about it which particularly distinguishes it from card 13C, the latter obtained from arrangement 8A.

Indicator card D is fairly representative of the pre-combustion chamber engines, samples of which are sketched at 9A and B.

Cards E and F were respectively obtained from opposed-spray engines similar to those sketched in Fig. 11B and A. Although made to appear different because of the different ratios of spring-scale to diagram-height used, there is nothing to distinguish them in a radical way from each other or from cards 13B and C.

Card G commands interest because it belongs to the engine sketched in Fig. 9D and because the form of the card appears to be a close replica of the "standard" card obtained from air-injection machines. Reference to Fig. 9D may give some clue how the "flat top" of card 13G is produced. It will be noted that the piston projection fitting the combustion space throat with only a slight clearance, causes a high degree of displacer action.

The amount of air trapped in the cylinder at the moment when the tip of the plug first begins to enter is large in comparison with the narrow ring-shaped channel through which it must be displaced as compression continues. Hence a blast of air having considerable force is probably projected into the combustion space at the moment when injection begins.

Promptness of ignition favored by accentuated air turbulence probably makes it necessary to use only a slight timing advance, which would account for the moderate rise in pressure clearly marking the commencement of burning. However, too much importance is not ascribed to this effect in view of the fact that even a sharp pressure rise would be slow in communicating itself to the body of the cylinder into which the indicator connection is tapped.

During the final phase of the combustion a turbulent rush of gases through the annular space between the piston plug and combustion space throat is favored by the combined action of volume increase in the cylinder and combustion pressure in the chamber.

High gas velocities obtained at this time are probably accompanied by intense burning action serving to keep up the pressure until the consumption of the last particle of fuel puts a sudden end to the process. Fairly adiabatic combustion substantially undisturbed by "after-burning" therefore ensues and yields the slender "toe" characteristic of this type of card.

The samples of fuel sprays and combustion chambers considered in this brief study all appear to unite in four salient facts relating to the combustion of heavy oil in an internal combustion engine.

Large amounts of energy—either pneumatically or hydraulically applied—are necessary (a) to reduce the oil to a sufficiently fine state of subdivision and (b) to accomplish this within the space of time available.

Hydraulic spray nozzles cannot simultaneously produce atomization of maximum fineness and penetration of maximum depth. In actual engines a medium is struck between the two extremes.

The more an actual airless spraying arrangement departs from this medium, the more dependent it is for success upon air turbulence produced in the combustion space by moulding it along with the piston crown.

Brooklyn Polytechnic Diesel Course

Evening Lectures, Recitations, and Laboratory Work
Begin Fresh Session in October

WITH the third consecutive repetition of the yearly course on Diesel and Oil Engines at the Polytechnic Institute, Brooklyn, N. Y., announced for the coming Fall, the belief has been confirmed that valuable service is being rendered by this instruction. Twenty two-hour lectures are to be given every Friday night at 99 Livingston St., Brooklyn, N. Y., beginning on October 1, 1926. As was the case last year, the lectures will be supplemented by class-room exercises and laboratory work. Mr. Kuttner, who delivered the lectures in previous years, will again be in charge.

The instruction on Diesel and oil engines given at the Polytechnic Institute is considered unique in that it aggressively drills the student in the mechanics and working of oil engines. The lecturer does not consider his task as having been fulfilled when he has passed a complete array of oil engine details in review before his students; he undertakes in addition to make the student's mind participate actively in dealing with the oil engine elements described by word of mouth and projected on a screen with the help of modern lantern equipment.

The object to be attained by this method of instruction is to reproduce, as nearly as can be done in the lecture room, the effect of handling, assembling, and responsibly operating repre-

sentative types of modern oil engines. Instead of following the usual text-book procedure of creating a flat picture lacking perspective in the student's mind, every effort is made to give depth and action to the presentation of the subject matter.

Special emphasis is laid in the course on those oil engine features which distinguish them in a characteristic way from other forms of power machinery and particularly from gas and gasoline engines. As a means to this end, scientific and mathematical fundamentals underlying these distinguishing features are thoroughly reviewed wherever they come up, care being taken, of course, to avoid loading down the course with an unnecessary weight of scientific paraphernalia.

No detailed survey of every existing type and kind of oil engine mechanism is attempted. Effort, on the other hand, is centered on drilling fundamentals so thoroughly that the student should have no difficulty in dealing effectively with whatever special oil engine problem he may be confronted with.

Laboratory work performed in connection with the single-cylinder Diesel engine available at the Institute carries out the general scheme of demonstrating fundamentals to the students, who are assembled fortnightly in

small groups for this purpose. The engine is assembled, dismounted, adjusted, and tested under power with a view to giving graphic illustrations to the points made in the course of the lectures.

Class-room exercises provide an excellent opportunity for reinforcing the work of instruction by the question-and-answer method. Experience has indicated that the effect on the student of talking over the things he is learning is useful in strengthening his grasp of them. Students are grouped in such a way that they report to their class and to the laboratory on alternating evenings each week, both meetings being arranged to avoid conflict with the lectures and with the personal arrangements of individuals.

Students may enroll either for the series of lectures alone (one evening a week) or for lectures, class room and laboratory (two evenings a week) at their option. Those who enroll for the entire course and who make a satisfactory record as regards attendance and proficiency, are awarded a certificate to that effect at the end of the course. Students may attend the first two lectures (October 1 and 8) without obligation, registrations being accepted by Professor Church, Polytechnic Institute, 99 Livingston St., Brooklyn, N. Y.

Letters to the Editor

Temperature Readings

To the Editor of MOTORSHIP:

I have read Mr. A. B. Newell's article entitled "Correct Temperature Readings Help Engines" published in your August issue with considerable interest and I consider that his article is very much more sensible, informed and pertinent than most articles on the subject of pyrometers and their application that we have seen. In fact, there is not a line in the article that I would take issue with, except where in connection with thermo-electric pyrometers which he has just been discussing and advocating, the author gives as one reason for their adoption that "they are inherently sturdy."

Unfortunately, they are not inherently sturdy but are inherently quite the reverse. With an ordinary thermocouple a change of 10 deg. Fahr. means a change of voltage in the thermocouple of only 0.0003 volt and therefore a measuring instrument which measures temperatures indirectly by measuring voltage change must, as its basic detector of temperature, employ a delicate galvanometer.

We have built such instruments in special form for the Shipping Board to be used as electric thermometers for cold storage temperatures and those instruments have been very successful and have been used for three years, but we had to build them in a very special way to fit them for use at sea and that made them so expensive that no one but the Shipping Board ever bought any. Various steamship lines refused to even consider them for a moment—they were so costly.

The writer recently came home from Sweden on the *Ms. GRIPSHOLM* and had the pleasure of going about the engine room with Mr. Thorell who expressed great interest in the matter of temperature measurement but deprecated strongly the idea of thermo-electric pyrometers because of the "dithering" in the engine room and because he wanted his temperature indications in the engine room and not in some other

part of the ship that is free from this. Such dithering as there is in the engine room of the *GRIPSHOLM* he considers might be too severe for any galvanometer whether of the type employed as a direct reading milli-volt meter or employed as the indicator of the null method or potentiometric pyrometer.

Electrical instruments for use at sea, if they are going to really be of service for a period of years, must be very differently constructed and differently housed and have very different electrical connections than are required for use on land, so that even aside from the matter of vibration, the necessarily greater expense for good electrical temperature measuring equipment suitable for use at sea, seems to quite frighten away the shipbuilder or shipowner, except in the case of the Shipping Board who actually did try some electrical instruments at sea and found them fit for only one or two trips and were for that reason willing to consider our instruments which were designed especially for sea use, notwithstanding the fact that they cost about three times as much as what they had previously purchased.

Not until the electrical instrument has been at sea for two or three years, can its real life be estimated or the cost of its maintenance be realized.

WILSON-MAEULEN CO., INC.,
CHAS. H. WILSON.

Personal

Harry A. Magoun has at his own request been relieved from active duty, and will hereafter act as consultant in the shipbuilding division of the American Brown Boveri Elec. Corp. Mr. Magoun joined the forces of the New York Shipbuilding Company as assistant to the president on August 1, 1907; he was made vice-president October 8 of the same year, and senior vice-president September 9, 1918.

William G. Groesbeck, vice-president of the American Brown Boveri Elec. Corp. since

September 9, 1918, has also requested to be relieved from administration duties and responsibilities. He will continue as vice-president, acting in an advisory capacity in all matters relating to procurement of shipbuilding contracts and will conduct all correspondence, etc., with the U. S. Navy and other divisions of the government. He will be assisted by Mr. R. A. Workman. W. S. Newell is appointed general manager of the Shipbuilding Division. He will have administrative control of all forces and the execution of all shipbuilding or other activities of this division.

L. J. Belnap, formerly president of Rolls Royce Corp. of America, has been elected president of Worthington Pump & Machinery Corp.

W. D. Coolidge, assistant director of the General Electric Co. Research Laboratory and inventor of an x-ray tube bearing his name has been awarded the Howard N. Potts gold medal for 1926 by the Franklin Institute of Philadelphia.

O. D. Treiber, associated with Carl G. Fisher and H. B. Joy, has formed a company to build Diesel engines especially for high class marine and yachting work. This company has connections with the American Brown Boveri Electric Corp. and will utilize the facilities of the New York Shipbuilding Corp. plant now owned and operated by the American Brown Boveri Electric Corp. located at Camden, N. J. Some contracts are on hand with the new company and these will be delivered in the early spring of 1927. Trieber Diesel Electric Corp. is the title of the new company, which will have offices in the Heckscher Bldg., 720 Fifth Ave., New York City, and also at the Camden plant of the American Brown Boveri Electric Corp.

Elmer A. Sperry, founder of the Sperry Gyroscope Co. was elected Chairman of the Board of Directors at a recent meeting of the stockholders and Charles S. Doran was elected President and General Manager.

Review of Recent Publications

Bulk Cargoes

By A. C. Hardy, B. Sc., A. M. Inst. N. A., A. M. I. Mar. E., 6¼ in. x 9¼ in. 160 pages. Price \$5.50. Published by D. Van Nostrand Co. Inc., New York.

In Hardy's latest book, vessels for the transportation of oil, ores, coal, grain and other cargoes in bulk shiploads are covered in a comprehensive survey. Oil tankers and ore carriers form the largest single groups of specialized ships in the whole world's tonnage. Their designs involve considerations that only the specialist is competent to treat, for the biggest problems involved are not those of pure naval architecture but of applied naval architecture.

Tankships for the carriage of crude oil may not always be the most efficient units for the transportation of gasoline. Tankers built for the Dutch oil trade have to satisfy other conditions than those which rule in the coastwise movement of oil from Gulf ports to Atlantic ports in the United States, as another example. It is not such detail matters that Hardy's book discusses specifically in the compact compass of 160 pages. It deals rather with the broad considerations, the generic reasons for the different designs of the various important classes of bulk carriers. In his earlier books, "Merchant Ship Types" and "Motorships" the author has shown that his forte is the selection of subjects that have not been treated by other authors, and the clear exposition of these subjects in simple language, devoid of mathematical frills. "Bulk Cargoes" follows the same style. It informs what the shipping world is doing with bulk cargo carriers, so that the man who knows only the Great Lakes ore trade can glean an idea of what is being done in other ore trades or the oil shipper learn how coal and grain are carried in bulk. The book forms a valuable introduction to the specialized branches of naval architecture involved in the bulk cargo business.

Diesel Engines

By D. L. Jones. 9 in. by 6 in. by 2 in. 536 pp. Price \$5.00. Published by the Norman W. Henley Publishing Co., New York.

"Diesel Engines" has seventeen chapters, the first one of which begins with a consideration of elementary thermodynamics, theoretical gas cycles and similar matters regarded as being more or less helpful to those engaged in the pursuit of knowledge concerning oil engines. This chapter is followed immediately by another devoted largely to diagrammatic representations of two and four-cycle machines and to a listing of oil engine elements such as fuel pump, compressor, spray bottle and similar matters, of whose existence it is necessary to apprise the uninitiated.

Under the heading of "Comparative efficiencies" the author presents tabular data listed as "Advantages of Diesel Engine Plants" and "Disadvantages of Steam Turbine Plants."

A series of several chapters are devoted to details of construction grouped in the usual way under headings to include bedplate, crankshaft and framing. Spray valves, fuel pumps, governors, and starting gears appear in the titles for the concluding chapters of this group.

There are three operating chapters, dealing with lubricating oil and cooling water systems, with indicator cards and engine testing, and with operating matters of a general character.

What may be called the catalog section of the book contains one long chapter entitled "Representative Types of Engines." It gives the usual sort of reports concerning the relative location of the various engine parts, without going too deeply into the question as to why they are so located. A sequel to this chapter is headed "A 1000 H.P. Submarine Diesel

Engine," this being acknowledged to the Magazine "Lubrication," published monthly by the Texas Company. Throughout the entire book, in fact, liberal use has apparently been made of articles which have appeared in the trade press, sometimes with, sometimes without acknowledgement. A sentence in the introduction mentioning a number of periodicals is perhaps intended to cover those appropriations of material for which no specific acknowledgement is made.

As an apparently strong believer in Diesel-electric drive for ships, the author devotes one of his longest chapters to this subject. He deals almost entirely with the electrical features of such propulsion systems in the evident conviction that the high-speed Diesel driving generators is intrinsically a more reliable mechanism than a moderate-speed engine direct-connected to the propeller shaft. Much of this idea seems to be based on the elimination of the reverse gear, not many other considerations being adduced on which to base a discrimination between the electric drive engine and the direct-connected machine. As far as the ship's installation as a whole is concerned, the author seems to be of the opinion that electric drive is superior for a wide variety of services.

"Diesel Engine Pointers" is a chapter reprinted with acknowledgement to the magazine "Power," which originally published them under the title "200 Diesel Engine Pointers." Lloyd's rules on vessels propelled by oil engines are reproduced in a separate chapter.

"Diesel Engines" is a book well made-up and fitted with a detailed index. Operating engineers and those generally interested in the oil engine trade will undoubtedly hasten to include it in their libraries.

Catalogs

Meco Duplex Strainers—A 4 pp. folder discussing the characteristics of this type of strainer which should be useful to engineers on motorships. Morton Engineering Co., 2050 N. Leithgow St., Philadelphia, Pa.

McNab Dial-O-Meter—12 pp. A useful booklet talking about the advantages, and characteristics of this gage which is designed to indicate in a simple manner the weight, height, and volume of any liquid contained in fuel oil, ballast, gasoline or other tanks regardless of the nature of such liquid. It is also suitable for measuring heights of water in reservoirs, or the depths of rivers and harbors, or the fore and aft draft of ships. McNab Corp., 1 Bright Place, Yonkers, N. Y.

Winton Marine Gasoline Engine—A 4 pp. folder detailing constructional details and giving dimensions of Model 124. The Winton Engine Co., 2116 West 106th St., Cleveland, Ohio.

Lidgerwood Super Utility Hoists—A leaflet giving particulars of gasoline driven hoists having a rope pull of 3500 lbs. at 200 ft. per min. rope speed. Lidgerwood Manufacturing Co., 96 Liberty St., New York City.

Marine Oil Engines for Direct & Diesel Drive—21 pages. This publication contains more than 30 illustrations featuring Ingersoll-Rand engines for direct connected and electrically driven motorships. The single lever control engine for direct connected drive are illustrated by engineroom views of the ferryboat HUDSON ATHENS and the tugs GRACE, SONITEP, HUSTLER, ROBERT C. BONHAM and the towboat SERA.

Non-reversing engines with Diesel-electric drive and with pilot house control, are represented by views of the J. W. VAN DYKE, VAN DYKE I, VAN DYKE II, VAN DYKE III. Ingersoll-Rand Co., 11 Broadway, New York City.

Regulators for Generator Voltage Control—55 pages. Publication No. 1734. This contains much information not published before on rheostatic-type automatic voltage regulators and special voltage regulator application. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Jenkins Modulating Valve—A 4 pp. folder descriptive of a patented valve recently offered to the trade. This is a valve in which the construction prevents foreign matter such as scale and core sand which falls from sections of cast iron radiators from lodging on the seat and hindering tight closing of the valve. Jenkins Bros., 80 White St., New York City.

Marine Diesel Engines—An attractive booklet, illustrating some recently built Harland & Wolff-B. & W. engines and ships, gives also a chart showing the number of motorships over 2000 gross tons in Lloyd's Register fitted with different types of Diesel engines. Burmeister & Wain heads this and is followed by Sulzer, Krupp, Werkspoor, M. A. N. and others. Harland & Wolff, Ltd., Belfast, Ireland.

Although we feel that the bookish, student type of man is about as useful in the engine room as a Tee-square on a workbench and no more, there is no denying that the man who uses his head can take about 25 per cent of the work off his back.

Strange how some men will spend three hours getting a nut off a stud rather than spend three seconds graphiting the threads before putting the nut on.

And when you have hammered the nut up until the stud breaks or the threads strip, then you know it was a little bit too tight.

Never could understand why an engineer would spend an hour cutting out a gasket while the whole job waits and never have a spare one ready after that.

Some shipowners would make good traffic cops. When they say go, they mean go—and no monkeying around holding up traffic.

If a man does not like to have the engine room painted white he will be wise to say nothing about it. We all know that colored paint gets dirtier than white paint because it does not show it, and the man who cries for dark colors just naturally dislikes keeping things clean.

Aside from the filth they harbor, dreary colors tend to make men dreary and indolent, though they may have been snappy and on the job before.

Classified Advertisements

50 CENTS PER LINE, 5 LINE MINIMUM, PAYABLE IN ADVANCE

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